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 117$^{\rm th}$ issue of the AGB Newsletter. Of the 21 refereed journal publications, eight deal directly with Planetary Nebulae — which may have something to do with planets after all, and perhaps with dark energy as well (see the contribution by Gibson & Schild).

Don't miss the many job advertisements, both for PhD studentships (Denver, Vienna, Portsmouth) and postdoctoral fellowships (Vienna, Keele).

The Food for Thought statement published last month generated some reaction. One of you considered the relation between rotation rate and magnetic activity to be the principal question in relation to AGB stars that needs to be answered. Hence, we make it this month's Food for Thought statement. Reactions to this, or suggestions for other pertinent questions, are very welcome and will be discussed in future issues of the newsletter.

The next issue will be distributed on the 1$^{\rm st}$ of March; the deadline for contributions is the 28$^{\rm th}$ of February.

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

The relation between rotation rate and magnetic activity is the principal question in relation to AGB stars that needs to be answered

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)

Magnetic fields in planetary nebulae and post-AGB nebulae.

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Magnetic fields are an important but largely unknown ingredient of planetary nebulae. They have been detected in oxygen-rich AGB and post-AGB stars, and may play a role in the shaping of their nebulae. Here we present SCUBA sub-millimeter polarimetric observations of four bipolar planetary nebulae and post-AGB stars, including two oxygen-rich and two carbon-rich nebulae, to determine the geometry of the magnetic field by dust alignment. Three of the four sources (NGC 7027, NGC 6537 and NGC 6302) present a well-defined toroidal magnetic field oriented along their equatorial torus or disk. NGC 6302 may also show field lines along the bipolar outflow. CRL 2688 shows a complex field structure, where part of the field aligns with the torus, whilst an other part approximately aligns with the polar outflow. It also presents marked asymmetries in its magnetic structure. NGC 7027 shows evidence for a disorganized field in the south-west corner, where the SCUBA shows an indication for an outflow. The findings show a clear correlation between field orientation and nebular structure.

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A Large Stellar Evolution Database for Population Synthesis Studies. III. Inclusion of the full Asymptotic Giant Branch phase and Web tools for stellar population analyses

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Stellar evolution tracks and isochrones are key inputs for a wide range of astrophysical studies; in particular, they are essential to the interpretation of photometric and spectroscopic observations of resolved and unresolved stellar populations. We have made available to the astrophysical community a large, homogenous database of up-to-date stellar tracks and isochrones, and a set of programs useful in population synthesis studies. In this paper we first summarize the main properties of our stellar model database BaSTI already introduced in Pietrinferni et al. (2004) and Pietrinferni et al. (2006). We then discuss an important update of the database, i.e., the extension of all stellar models and isochrones until the end of the thermal pulses along the Asymptotic Giant Branch. This extension of the library is particularly relevant for stellar population analyses in the near-infrared, or longer wavelengths, where the contribution to the integrated photometric properties by cool and bright Asymptotic Giant Branch stars is significant. A few comparisons with empirical data are also presentend and briefly discussed. We then present three web-tools that allow an interactive access to the database, and make possible to compute user-specified evolutionary tracks, isochrones, stellar luminosity functions, plus synthetic Color-Magnitude-Diagrams and integrated magnitudes for arbitrary Star Formation Histories. All these web tools are available at the BaSTI database official site: http://www.oa-teramo.inaf.it/BASTI

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Available from astro-ph/0612669
and from http://astro.ensc-rennes.fr http://www.oa-teramo.inaf.it/BASTI

VLA Observations of H I in the Circumstellar Envelopes of AGB Stars

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We have used the Very Large Array (VLA) to search for neutral atomic hydrogen (H I) in the circumstellar envelopes of five asymptotic giant branch (AGB) stars. We have detected H I 21-cm emission coincident in both position and velocity with the S-type semi-regular variable star RS Cnc. The emission comprises a compact, slightly elongated feature centered on the star with a mean diameter of $\sim 82''$ (1.5×10^{17} cm), plus an additional filament extending $\sim 6'$ to the northwest. If this filament is associated with RS Cnc, it would imply that a portion of its mass-loss is highly asymmetric. We estimate $M_{\rm H\,I} \approx 1.5 \times 10^{-3}$ $M_\odot$ and a mass-loss rate $\dot{M} \approx 1.7 \times 10^{-7}$ $M_\odot$ yr^{-1}. Toward three other stars (IRC+10216, EP Aqr, R Cas), we have detected arcminute-scale H I emission features at velocities consistent with the circumstellar envelopes, but spatially offset from the stellar positions. Toward R Cas, the emission is weak but peaks at the stellar systemic velocity and overlaps with the location of its circumstellar dust shell and thus is probably related to the star. In the case of IRC+10216, we were unable to confirm the detection of H I in absorption against the cosmic background previously reported by Le Bertre & Gérard. However, we detect arcs of emission at projected distances of $r \sim 14' - 18'$ ($\sim 2 \times 10^{18}$ cm) to the northwest of the star. The large separation of the emission from the star is feasible given its advanced evolutionary status, although it is unclear if the asymmetric distribution and complex velocity structure are consistent with a circumstellar origin. For EP Aqr, the detected H I emission comprises multiple clumps redward of the systemic velocity, but we are unable to determine unambiguously whether the emission arises from the circumstellar envelope or from interstellar clouds along the line-of-sight. Regardless of the adopted distance for the H I clumps, their inferred H I masses are at least an order of magnitude smaller than their individual gravitational binding masses. We did not detect any H I emission from our fifth target, R Aqr (a symbiotic binary), but measured a 1.4 GHz continuum flux density of 18.8±0.7 mJy. R Aqr is a previously known radio source, and the 1.4 GHz emission likely arises primarily from free-free emission from an ionized circumbinary envelope.

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Ruling out a massive asymptotic giant-branch star as the progenitor of supernova 2005cs

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We calculate the predicted $UBVRIJHK$ absolute magnitudes for models of supernova progenitors and apply the result to the case of supernova 2005cs. We agree with previous results that the initial mass of the star was of low, around 6 to 8 $M_\odot$. However such stars are thought to go through second dredge-up to become AGB stars. We show that had this occurred to the progenitor of 2005cs it would have been observed in JHK pre-explosion images. The progenitor was not detected in these bands and therefore we conclude that it was not an AGB star. Furthermore if some AGB stars do produce supernovae they will have a clear signature in pre-explosion near-infrared images. Electron-capture supernovae are thought to occur in AGB stars, hence the implication is that 2005cs was not an electron-capture supernova but was the collapse of an iron core.

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First detection of photospheric depletion in the LMC

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CONTEXT. Recent photospheric abundance studies of galactic field RV Tauri stars show that depletion of refractory elements is rather common in these evolved objects. AIMS. The process that creates this chemical anomaly is not understood well, but it probably requires the presence of gravitationally bound dust in a binary system. We test for the presence of depletion in extra-galactic objects. METHODS. A detailed photospheric abundance study on the basis of high-quality UVES spectra was performed on the RV Tauri star in the LMC: MACHO 82.8405.15. Abundances were derived using a critically compiled line list with accurate log(gf) values and the latest Kurucz model atmospheres. RESULTS. With $[\mathrm{Fe/H}] = -2.6$ in combination with $[\mathrm{Zn/Fe}] = +2.3$ and $[\mathrm{S/Ti}] = +2.5$, MACHO 82.8405.15 displays a strong depletion abundance pattern. The effect of the depletion is comparable to the strongest depletions seen in field Galactic RV Tauri stars. CONCLUSIONS. The chemical analysis of MACHO 82.8405.15 proves that the depletion process also occurs in the extragalactic members of the RV Tauri pulsation class. Our program star is a member of a larger sample of LMC RV Tauri objects. This sample is unique, since the distances of the members are well-constrained. Further studies of this sample are therefore expected to gain deeper insight into the poorly understood depletion phenomenon and of the evolutionary status of RV Tauri stars in general.

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HST and VLT observations of the Symbiotic Star Hen 2-147

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We investigate the dynamics of the nebula around the symbiotic star Hen 2-147, determine its expansion parallax, and compare it with the distance obtained via the Period-Luminosity relation for its Mira variable. A combination of multi-epoch HST images and VLT integral field high-resolution spectroscopy is used to study the nebular dynamics both along the line of sight and in the plane of the sky. The geometry of the nebula is found to be that of a knotty annulus of ionized gas inclined to the plane of sky and expanding with a velocity of $\sim$90 km s^{-1}. A straightforward application of the expansion parallax method provides a distance of 1.5 ± 0.4 kpc, which is a factor of two lower than the distance of 3.0 ± 0.4 kpc obtained from the Period-Luminosity relationship for the Mira (which has a pulsation period of 373 days). The discrepancy is removed if, instead of expanding matter, we are observing the expansion of a shock front in the plane of the sky. This shock interpretation is further supported by the broadening of the nebular emission lines.

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Metal Absorption Profiles from the Central Star of the Planetary Nebula M27 (NGC 6853, PN G060.8−03.6, the Dumbbell) – Photospheric and Nebular Line Identifications

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High resolution spectra of the hot central star of the planetary nebula (CSPN) M27, acquired with the Far Ultraviolet Spectroscopic Explorer (FUSE), have revealed an unusually rich set of narrow molecular hydrogen absorption features. This object is also unique in that the velocity of nebular absorption features are cleanly separated from the velocity of the intervening interstellar medium. These features blend with and in many cases obscure atomic features. We have developed a continuum model of the CSPN including atomic and molecular hydrogen absorption. Using this model we have identified and tabulated the metal lines as arising from either photospheric, nebular and/or non-nebular velocity systems. We find the nebular outflow and ionization balance to be stratified with high ionization states favored at low velocity and low ionization states favored at high velocity. Neutrals and molecules are found at a velocity that marks the transistion between these two regimes. These observations are a challenge to the interacting wind model of PN evolution. Mappings at high resolution of the line profiles for C I-IV, N I-III, O I, O VI, Si II-IV, P II-V, S II-IV, Ar I-II and Fe II-III within the FUSE and STIS bandpasses are presented. The digitial spectra of the stars and the model are freely available on the H_2ools website. They will be useful for photospheric analyses seeking to determine the metallicity of the central star and for absorption line based atomic and molecular abundance determination of the nebular outflow.

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Molecular and Atomic Excitation Stratification in the Outflow of the Planetary Nebula M27

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High resolution spectroscopic observations with *FUSE* and *HST* STIS of atomic and molecular velocity stratification in the nebular outflow of M27 challenge models for the abundance kinematics in planetary nebulae. The simple picture of a very high speed ($\sim$ 1000 km s^{-1}), high ionization, radiation driven stellar wind surrounded by a slower ($\sim$ 10 km s^{-1}) mostly molecular outflow, with low ionization and neutral atomic species residing at the wind interaction interface, is not supported by the M27 data. We find no evidence for a high speed radiation driven wind. Instead there is a fast (33 – 65 km s^{-1}) low ionization zone, surrounding a slower ($\lesssim$ 33 km s^{-1}) high ionization zone and, at the transition velocity (33 km s^{-1}), vibrationally excited H_2 is intermixed with a predominately neutral atomic medium. The ground state H_2 ro-vibrational population shows detectable absorption from J" $\lesssim$ 15 and v" $\lesssim$ 3. Far-UV continuum fluorescence of H_2 is not detected, but Lyman α (Lyα) fluorescence is present. We also find the diffuse nebular medium to be inhospitable to molecules and dust. Maintaining the modest equilibrium abundance of H_2 ($\frac{N(H_2)}{N(H\,I)} \ll 1$) in the diffuse nebular medium requires a source of H_2, mostly likely the clumpy nebular medium. The stellar spectral energy distribution shows no signs of reddening ($E(B-V) < 0.01$), but paradoxically measurements of Hα/Hβ reddening found in the literature, and verified here using the *APO* DIS, indicate $E(B-V) \sim 0.1$. We argue the apparent enhancement of Hα/Hβ in the absence of dust may result from a two step process of H_2 ionization by Lyman continuum (Lyc) photons followed by dissociative recombination ($H_2 + \gamma \rightarrow H_2^+ + e^- \rightarrow H(1s) + H(nl)$), which ultimately produces fluorescence of Hα and Lyα. In the optically thin limit at the inferred radius of the velocity transition we find dissociation of H_2 by stellar Lyc photons is an order of magnitude more efficient than spontaneous

dissociation by far-UV photons. We suggest that the importance of this H_2 destruction process in H II regions has been overlooked.

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Long Secondary Periods and Binarity in Red Giant Stars

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Observational arguments supporting the binary explanation of the long secondary periods (LSP) phenomenon in red giants are presented. Photometry of about 1200 semiregular variables with the LSP in the Large Magellanic Cloud are analyzed using the MACHO and OGLE photometry. For about 5% of these objects additional ellipsoidal-like or eclipsing-like modulation with the same periods as the LSP is detectable. These double-humped variations are usually shifted in phase comparing to the LSP light curves. I discuss the model of binary system with a red giant as the primary component and a low-mass object as the secondary one. The mass lost by the red giant through the wind follows the spiral pattern in the orbit around the primary star and obscures it causing the LSP variations.

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Mid Infrared Photometry of Mass-Losing AGB Stars.

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We present ground-based mid-infrared imaging for 27 M-, S- and C-type Asymptotic Giant Branch (AGB) stars. The data are compared with those of the database available thanks to the IRAS, ISO, MSX and 2MASS catalogues. Our goal is to establish relations between the IR colors, the effective temperature T_{eff}, the luminosity L and the mass loss rate $\dot{M}$, for improving the effectiveness of AGB modelling. Bolometric (absolute) magnitudes are obtained through distance compilations, and by applying previously-derived bolometric corrections; the variability is also studied, using data accumulated since the IRAS epoch. The main results are: i) Values of L and $\dot{M}$ for C stars fit relations previously established by us, with Miras being on average more evolved and mass losing than Semiregulars. ii) Moderate IR excesses (as compared to evolutionary tracks) are found for S and M stars in our sample: they are confirmed to originate from the dusty circumstellar environment. iii) A larger reddening characterizes C-rich Miras and post-AGBs. In this case, part of the excess is due to AGB models overestimating T_{eff} for C-stars, as a consequence of the lack of suitable molecular opacities. This has a large effect on the colors of C-rich sources and sometimes disentangling the photospheric and circumstellar contributions is difficult; better model atmospheres should be used in stellar evolutionary codes for C stars. iv) The presence of a long-term variability at mid-IR wavelengths seems to be limited to sources with maximum emission in the 8 – 20 μm region, usually Mira variables (1/3 of our sample). Most Semiregular and post-AGB stars studied here remained remarkably constant in mid-IR over the last twenty years.

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Minkowski's Footprint revisited. Planetary Nebula formation from a single sudden event?

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M1-92 can be considered an archetype of bipolar pre-planetary nebulae. It shows a clear axial symmetry, along with the kinematics and momentum excess characteristic of this class of envelopes around post-AGB stars. By taking advantage of the new extended configuration of the IRAM Plateau de Bure interferometer, we wanted to study the morphology and velocity field of the molecular gas better in this nebula, particularly in its central part. We performed sub-arcsecond resolution interferometric observations of the J=2-1 rotational line ^{13}CO M1-92. We found that the equatorial component is a thin flat disk, which expands radially with a velocity proportional to the distance to the center. The kinetic age of this equatorial flow is very similar to that of the two lobes. The small widths and velocity dispersion in the gas forming the lobe walls confirm that the acceleration responsible for the nebular shape could not last more than 100-120 yr. The present kinematics of the molecular gas can be explained as the result of a single brief acceleration event, after which the nebula reached an expansion velocity field with axial symmetry. In view of the similarity to other objects, we speculate on the possibility that the whole nebula was formed as a result of a magneto-rotational explosion in a common-envelope system.

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Interpretation of the Helix Planetary Nebula using Hydro-Gravitational-Dynamics: Planets and Dark Energy

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Hubble Space Telescope (HST/ACS) images of the Helix Planetary Nebula (NGC 7293) are interpreted using the hydro-gravitational-dynamics theory (HGD) of Gibson 1996-2006. HGD predicts that baryonic-dark-matter (BDM) dominates the mass of galaxies (Schild 1996) as Jovian (promordial-fog-particle, PFP) Planets (JPPs) in proto-globular-star-cluster (PGC) clumps within galaxy halo diameters surrounding its stars. From HGD, supernova Ia (SNe Ia) events normally occur in planetary nebulae (PNe) within PGCs where binary clustering cascades of merging planets produce central binary star systems. As central stars of PNe, binaries exchange mass and accrete JPPs to grow white-dwarfs to 1.44 $M_\odot$ instability within ionized (Oort cloud) cavities bounded by evaporating JPPs. SNe Ia events are thus intermittently obscured by radiation-inflated JPP atmospheres producing systematic SNe Ia distance errors, so the otherwise mysterious "dark energy" concept is unnecessary. HST/ACS and WFPC2 Helix images show > 7000 cometary globules, here interpreted as gas-dust cocoons of JPPs evaporated by beamed radiation from its white-dwarf plus companion central binary star system. Mass for growing the stars, the PNe, and possibly a SNe Ia event, is accreted gravitationally from ambient BDM JPPs. Measured JPP masses $\approx 3\times10^{25}$ kg with spacing $\approx 10^{14}$ m support the HGD prediction that the density ρ of galaxy star forming regions fossilize the density $\rho_0 \approx (3-1)\times10^{-17}$ kg m^{-3} existing at 30,000 years in the plasma-epoch, when proto-superclusters fragmented in the expanding universe giving the first gravitational structures.

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Infrared Emission from the Dusty Disk Orbiting GD 362, An Externally-Polluted White Dwarf

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We report Spitzer Space Telescope photometry between 3.6 μm and 24 μm and spectroscopy between 5 μm and 15 μm of GD 362, a white dwarf with an effective temperature near 10,000 K that displays a remarkably high concentration of metals in its atmosphere and a thermal infrared excess. We approximately reproduce both the infrared continuum and the very strong 10 μm silicate emission feature with a model of an orbiting disk which is flat out to 50 stellar radii and warped between 50 and 70 stellar radii. The relatively small amount of cold material implied by the weak 24 μm flux argues that the disk lies within the Roche radius of the star, and we may be witnessing a system where an asteroidal-size body has been tidally destroyed. If so, determination of the photospheric metal abundances may measure the bulk composition of an extrasolar minor planet.

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A Dusty Disk Around WD1150-153: Explaining the Metals in White Dwarfs by Accretion from the Interstellar Medium versus Debris Disks

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We report the discovery of excess K-band radiation from a metal-rich DAV white dwarf star, WD1150-153. Our near infrared spectroscopic observations show that the excess radiation cannot be explained by a (sub)stellar companion, and is likely to be caused by a debris disk similar to the other DAZ white dwarfs with circumstellar debris disks. We find that the fraction of DAZ white dwarfs with detectable debris disks is at least 14%. We also revisit the problem of explaining the metals in white dwarf photospheres by accretion from the interstellar medium (ISM). We use the observed interstellar column densities toward stars in close angular proximity and similar distance as DAZ white dwarfs to constrain the contribution of accretion from the ISM. We find no correlation between the accretion density required to supply metals observed in DAZs with the densities observed in their interstellar environment, indicating that ISM accretion alone cannot explain the presence of metals in nearby DAZ white dwarfs. Although ISM accretion will certainly contribute, our analysis indicates that it is not the dominant source of metals for most DAZ white dwarfs. Instead, the growing number of circumstellar debris disks around DAZs suggests that circumstellar material may play a more dominant role in polluting the white dwarf atmospheres.

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Determination of the Physical Conditions of the Knots in the Helix Nebula from Optical and Infrared Observations

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We use new Hubble Space Telescope and archived images to clarify the nature of the ubiquitous knots in the Helix Nebula, which are variously estimated to contain a significant to majority fraction of the material ejected by its central star.

We employ published far infrared spectrophotometry and existing 2.12 μm images to establish that the population distribution of the lowest ro-vibrational states of H_2 is close to the distribution of a gas in local thermodynamic equilibrium (LTE) at 988 ± 119 K. In addition, we present calculations that show that the weakness of the H_2 0-0 S(7) line is not a reason for making the unlikely-to-be true assumption that H_2 emission is caused by shock excitation.
We derive a total flux from the nebula in H_2 lines and compare this with the power available from the central star for producing this radiation. We establish that neither soft X-rays nor 912–1100 Å radiation has enough energy to power the H_2 radiation, only the stellar extreme ultraviolet radiation shortward of 912 Å does. Advection of material from the cold regions of the knots produces an extensive zone where both atomic and molecular hydrogen are found, allowing the H_2 to directly be heated by Lyman continuum radiation, thus providing a mechanism that will probably explain the excitation temperature and surface brightness of the 2.12 μm cusps and tails.
New images of the knot 378-801 in the H_2 2.12 μm line reveal that the 2.12 μm cusp lies immediately inside the ionized atomic gas zone. This property is shared by material in the "tail' region. The H_2 2.12 μm emission of the cusp confirms previous assumptions, while the tail's property firmly establishes that the "tail" structure is an ionization bounded radiation shadow behind the optically thick core of the knot. The new 2.12 μm image together with archived Hubble images is used to establish a pattern of decreasing surface brightness and increasing size of the knots with increasing stellar distance. Although the contrast against the background is greater in 2.12 μm than in the optical lines, the higher resolution and signal of optical images remains the most powerful technique for searching for knots.
A unique new image of a transitional region of the nebula's inner disk in the He II 4686 Å line fails to show any emission from knots that might have been found in the He^{++} core of the nebula. We also re-examined high signal-to-noise ratio ground-based telescope images of this same inner region and found no evidence of structures that could be related to knots.

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HV 11423: The Coolest Supergiant in the SMC

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We call attention to the fact that one of the brightest red supergiants in the SMC has recently changed its spectral type from K0-1 I (December 2004) to M4 I (December 2005) and back to K0-1 I (September 2006). An archival spectrum from the Very Large Telescope reveals that the star was even cooler (M4.5-M5 I) in December 2001. By contrast, the star was observed to be an M0 I in both October 1978 and October 1979. The M4-5 I spectral types is by far the latest type seen for an SMC supergiant, and its temperature in that state places it well beyond the Hayashi limit into a region of the H-R diagram where the star should not be in hydrostatic equilibrium. The star is variable by nearly 2 mag in V, but essentially constant in K. Our modeling of its spectral energy distribution shows that the visual extinction has varied during this time, but that the star has remained essentially constant in bolometric luminosity. We suggest that the star is currently undergoing a period of intense instability, with its effective temperature changing from 4300 K to 3300 K on the time-scale of months. It has one of the highest 12 μm fluxes of any RSG in the SMC, and we suggest that the variability at V is due primarily to changes in effective temperature, and secondly, due to changes in the local extinction due to creation and dissipation of circumstellar dust. We speculate that the star may be nearing the end of its life.

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Probing clumpy pasts of galaxies from AGB stars

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Recent morphological studies of galaxies by the Hubble Space Telescope (HST) have revealed that actively star-forming galaxies at intermediate and high redshifts ($z = 0.5 - 2.0$) have very clumpy and irregular distributions of stars. It is however unclear whether and how these clumpy galaxies evolve into the present spiral and elliptical galaxies with regular shapes. We here propose that spatial distributions of AGB stars, probing the different mean age and metallicity of the underlying stellar population, can provide vital clues to the evolution of these clumpy galaxies, in particular, those at intermediate redshifts. In order to demonstrate this proposal to be quite promising, we show the results of test-particle simulations on the long-term dynamical evolution of unbound groups of AGB stars ("stellar clumps"), which correspond to the successors of star-forming clumps at intermediate redshifts, in isolated and interacting galaxies. We particularly show that azimuthal distributions of AGB stars dispersed from stellar clumps as a result of gravitational interaction with their host galaxies can be still inhomogeneous several Gyrs after stellar clump formation for some models. We also show that the inhomogeneities in the azimuthal distributions of dispersed AGB stars can more quickly disappear in stellar clumps with larger sizes and higher velocity dispersions. These results suggest that if apparently clumpy structures of galaxies at intermediate redshifts are due to stars in unbound or weakly bound clusters, spatial distributions of AGB stars can have fossil records on past clumpy structures of galaxies.

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Germanium Production in Asymptotic Giant Branch stars: Implications for Observations of Planetary Nebulae

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Observations of planetary nebulae (PNe) by Sterling, Dinerstein and Bowers have revealed abundances in the neutron-capture element Germanium (Ge) from solar to factors of 3 – 10 above solar. The enhanced Ge is an indication that the *slow*-neutron capture process (*s* process) operated in the parent star during the thermally-pulsing asymptotic giant branch (TP-AGB) phase. We compute the detailed nucleosynthesis of a series of AGB models to estimate the surface enrichment of Ge near the end of the AGB. A partial mixing zone of constant mass is included at the deepest extent of each dredge-up episode, resulting in the formation of a ^{13}C pocket in the top $\sim 1/10^{\rm th}$ of the He-rich intershell. All of the models show surface increases of [Ge/Fe] $\lesssim$0.5, except the 2.5 M$_\odot$, $Z = 0.004$ case which produced a factor of 6 enhancement of Ge. Near the tip of the TP-AGB, a couple of extra TPs could occur to account forthe composition of the most Ge-enriched PNe. Uncertainties in the theoretical modeling of AGB stellar evolution might account for larger Ge enhancements than we predict here. Alternatively, a possible solution could be provided by the occurrence of a late TP during the post-AGB phase. Difficulties related to spectroscopic abundance estimates also need to be taken into consideration. Further study is required to better assess how the model uncertainties affect the predictions and, consequently, if a late TP should be invoked.

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HST/NICMOS Imaging Polarimetry of Proto-Planetary Nebulae II: Macro-morphology of the Dust Shell Structure via Polarized Light

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The structure of the dusty circumstellar envelopes (CSEs) of proto-planetary nebulae (PPNs) reveals the mass-loss history of these sources and how such histories may differ for elliptical (SOLE) and bipolar (DUPLEX) PPNs. To study the PPN structures via dust-scattered linearly polarized starlight, we have compiled the imaging-polarimetric data for all 18 evolved stars that have been obtained to date with NICMOS on-board the *Hubble Space Telescope* (*HST*). This alternative imaging technique provides a unique way to probe the distribution of dust grains that scatter light around evolved stars. The new perspective gained from the imaging-polarimetric data has revealed several new aspects to the structures of PPNs. Point-symmetry is a prevalent imaging-polarimetric characteristic resulting from the azimuthal density gradient in the CSEs. Among these point-symmetric nebulae, three detailed morphological types can be differentiated by their polarized intensity, I_{pol}, and polarization strength, P. While the azimuthal density gradient is reversed above and below the equatorial plane in optically thicker bipolar nebulae, there is no gradient reversal in optically thinner elliptical nebulae. The equatorial plane of the system defined by the integrated angle of polarization is not necessarily orthogonal to the axis of the apparent bipolar structure in the total intensity data.

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Carbon Stars and C/M Ratio in the WLM Dwarf Irregular Galaxy

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We identify the rich Carbon star population of the Magellanic-type dwarf irregular galaxy WLM (Wolf-Lundmark-Melotte) and study its photometric properties from deep near-IR observations. The galaxy exhibits also a clear presence of Oxygen rich population. We derive a Carbon to M-star ratio of $C/M = 0.56 \pm 0.12$, relatively high in comparison with many galaxies. The spatial distribution of the AGB stars in WLM hints at the presence of two stellar complexes with a size of a few hundred parsecs. Using the HI map of WLM and the derived gas-to-dust ratio for this galaxy we re-determined the distance modulus of WLM from the IR photometry of four known Cepheids, obtaining $(m - M)_0 = 24.84 \pm 0.14$ mag. In addition, we determine the scale length of 0.75 ± 0.14 kpc of WLM disk in J-band.

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A snapshot of the inner dusty regions of a R CrB-type variable

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R Coronae Borealis (RCrB) variable stars are suspected to sporadically eject optically thick dust clouds causing, when one of them lies on the line-of-sight, a huge brightness decline in visible light. Direct detections with 8-m class adaptive optics of such clouds located at about 0.2-0.3 arcsec from the centre (∼1000 stellar radii) were recently reported by de Laverny & Mékarnia (2004) for RY Sgr, the brightest RCrB of the southern hemisphere. Mid-infrared interferometric

observations of RY Sgr allowed us to explore the circumstellar regions much closer to the central star (∼20-40 mas) in order to look for the signature of any heterogeneities and to characterize them. Using the VLTI/MIDI instrument, five dispersed visibility curves in the N band were recorded in May and June 2005 with different projected baselines oriented towards two roughly perpendicular directions. The large spatial frequencies visibility curves exhibit a sinusoidal shape whereas, at shorter spatial frequencies visibility curves follow a Gaussian dec rease. These observations are well interpreted with a geometrical model consisting in a central star surrounded by an extended circumstellar envelope in which one bright cloud is embedded. Within this simple geometrical scheme, the inner 110 AU dusty environment of RY Sgr is dominated at the time of observations by a single dusty cloud which, at 10 μm represents ∼10% of the total flux of the whole system, slightly less that the star flux. The cloud is located at about 100 stellar radii (or ∼30 AU) from the centre toward the East-North-East direction (or the symmetric direction with respect to centre) within a circumstellar envelope which FWHM is about 120 stellar radii. This first detection of a cloud so close to the central star, supports the classical scenario of the RCrB brightness variations in the optical spectral domain and demonstrates the feasibility of a temporal monitoring of the dusty environment of this star at a monthly scale.

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Conference Papers

Population synthesis models including AGB stars and their ingredients

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I will briefly review the state of the art of evolutionary population synthesis (EPS) models that include the contribution from AGB stars.

Oral contribution, published in Why galaxies care about AGB stars, Vienna, August 7-11, 2006
Available from astro-ph/0701536

Towards simulating the photometry, chemistry, mass loss and pulsational properties of AGB star populations in resolved galaxies

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Extended and updated grids of TP-AGB tracks have been implemented in the TRILEGAL population synthesis code, which generates mock stellar catalogues for a galaxy given its mass, distance, star formation history and age-metallicity relation, including also the Milky Way foreground population. Among the stellar parameters that are simulated, we now include the surface chemistry, mass-loss rates, pulsation modes and periods of LPVs. This allows us to perform a series of consistency checks between AGB model predictions and observations, that we are just starting to explore. We present a few examples of model–data comparisons, mostly regarding the near-infrared and variability data for AGB stars in the Magellanic Clouds.

Oral contribution, published in Why galaxies care about AGB stars, Vienna, August 7-11, 2006
Available from astro-ph/0701533

The first stages of the evolution of Globular Clusters

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The majority of the inhomogeneities in the chemical composition of Globular Cluster (GC) stars appear due to primordial enrichment. The most studied model today claims that the ejecta of Asymptotic Giant Branch (AGB) stars of high mass —those evolving during the first ∼100 Myr of the Clusters life— directly form a second generation of stars with abundance anomalies. In this talk, we review the status of the art with regard to this model, whose major problems are *i:* the modelling of the chemical anomalies is still not fully complete, and *ii:* it requires an IMF peculiarly enhanced in the intermediate mass stars. The model predicts enhanced helium abundance in the stars showing chemical anomalies, and the helium abundance distribution can be roughly derived from the morphology of the horizontal branch. Such distribution may possibly help to falsify the model for the first phases of evolution of GCs. As an illustration, we compare the results of the analysis of the HB morphology of some clusters.

Oral contribution, published in "From Stars to Galaxies: Building the Pieces to Build up the Universe", Venice, October 16-20, 2006, Astronomical Society of the Pacific Conference Series, Eds. A. Vallenari, R. Tantalo, L. Portinari and A. Moretti
Available from astro-ph/0612654

Job Adverts

Astronomy Graduate Program at the University of Denver

The Department of Physics and Astronomy at the University of Denver is currently accepting applications for its graduate program. Opportunities exist for those who seek an astrophysics graduate program specialized in evolved star research, in particular using data obtained by the Spitzer Space Telescope and the AKARI Infrared Astronomy Satellite. Astrophysics faculty include Dr. Robert Stencel and Dr. Toshiya Ueta, and plans are progressing for a third astronomy faculty member joining us in the fall of 2007. Please send inquiries to rstencel@du.edu and/or tueta@du.edu and visit our website at http://www.physics.du.edu/. Early action deadline is February 15 and we will be making offers as soon as possible thereafter.

See also http://www.physics.du.edu/

Institute for Astronomy - Vienna (Austria): Postdoctoral and Doctoral positions

The working group for Asymptotic Giant Branch Stars at the Institute of Astronomy, University of Vienna, is inviting applications for one Postdoctoral and one Doctoral position in the area of stellar atmospheres and optical interferometry.

The **Doctoral position** is for 2+1 years and candidates shall have some background in the theory and observation of stellar atmospheres and a strong interest in optical interferometry. The PhD work shall be devoted to radiative transfer calculations based on dynamic model atmospheres and a comparison with existing and new interferometric data. The salary is about Euro 17.000,- per annum (take home, no university fees).

The **Postdoc position** is for 2+1 years and the successful candidate shall have experience in the preparation and analysis of interferometric data, preferably for the ESO VLTI, and he/she shall have an interest in the topic of stellar atmospheres. The candidate is expected to devote a significant amount of his/her time to work in connection with the realization of 2nd Generation VLTI instruments (VSI, MATISSE). The salary is about Euro 26.000,- per annum (take home).

The Institute of Astronomy offers a broad choice of astronomy education and research topics and a very good working environment. The interests and expertise of the AGB-group comprise model atmospheres, molecular and dust spectroscopy, abundance determinations, AGB-stars in stellar systems, stellar variability, mass loss and laboratory astrophysics. The group collaborates with many researchers at international level and is involved in HERSCHEL-PACS, VSI and GAIA. Further information can be found at www.univie.ac.at/astro .

The positions are funded via an Austrian Science Fund project (see www.fwf.ac.at for financial details) and work should start in spring/summer 2007. Applications for the Postdoc position should consist of a CV, a publications list, a statement on the candidates research interests and at least two reference letters. For the PhD position a CV, publication list and at least one reference letter are requested.

The material should be sent by March 15, 2007 to:
Prof. Josef HRON
Institute of Astronomy
University of Vienna
Türkenschanzstraße 17
A-1180 Vienna
AUSTRIA
Fax number: +43-1-4277-9518
Questions about the positions may be directed to hron@astro.univie.ac.at

See also http://www.univie.ac.at/astro

Postdoctoral Fellowship in Astrophysics

Applications are invited for a post-doctoral fellowship in the Astrophysics Group at Keele University. We are looking for a researcher with expertise and interests at the intersection of stellar nucleosynthesis, evolution and hydrodynamics. The appointee will work with Dr. Falk Herwig and research team members at the Joint Institute for Nuclear Astrophysics (JINA) and Los Alamos National Laboratory (LANL) in the US. To realize the collaborative aspects of this project it is expected that the appointee takes advantage of the opportunity to spend one quarter of each year at these participating institutions.

Our group (see http://www.astro.keele.ac.uk) is currently expanding to ten academic staff. We work in a wide range of fields mostly related to stars and their environments. The group is supported by a PPARC rolling grant.

The post is jointly funded 75% by a European Union grant to Keele and 25% by JINA, and is available initially for 2 years, with the a possibility for a third year depending on project progress and continued availability of funding. We have excellent computational resources for this project as well as adequate travel support. The position is open immediately.

Job packs are available from Human Resources Department, Keele University, vacancies@keele.ac.uk or www.keele.ac.uk/depts/uso/hr/cwisvacs.htm. Inquiries: Dr Falk Herwig (fherwig@astro.keele.ac.uk) or Prof Nye Evans (ae@astro.keele.ac.uk). Electronic applications to be submitted to vacancies@keele.ac.uk by March 5th, 2007. Applicants should arrange to have three letters of reference sent to this address by that date as well.

Please quote post reference: RE07/05

See also http://www.jobs.ac.uk/jobfiles/SH383.html

PhD positions

INSTITUTE OF COSMOLOGY AND GRAVITATION
UNIVERSITY OF PORTSMOUTH
UNITED KINGDOM

PhD Studentships 2007

Research Projects in Stellar Population Modelling and Galaxy Evolution (supervisor: Dr Claudia Maraston)

Contact: Chris Jones, Research Administrator
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fax: +44 23 9284 5626
web: www.icg.port.ac.uk

The Institute of Cosmology & Gravitation at the University of Portsmouth is a young, dynamic research department with RAE grade 5. We have 10 academic staff, 12 postdoctoral researchers and 18 PhD students. The ICG is a member of the Sloan Digital Sky Survey and of the UK cosmology supercomputer consortium. Group members participate in many international research collaborations, and we have a very active visitor programme.

The two studentships are funded by the European Community through a Marie Curie Excellence Grant and offer a salary including social insurances and pensions to students. The positions are open to students of any nationality.

Applications should reach us by 23$^{\rm rd}$ February 2007, but will be considered until the positions are filled.

PhD applicants should have or expect to obtain a good honours degree or equivalent in Astronomy or Physics. Applicants should send a CV and application form (see ICG website), a brief statement of general research interests, and arrange for 2 letters of recommendation to be emailed directly to

chris.jones@port.ac.uk,

or posted to:

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Prof Bob Nichol
Prof David Wands
Dr David Bacon
Dr Marco Bruni
Dr Rob Crittenden
Dr Kazuya Koyama
Dr Claudia Maraston
Dr Will Percival
Dr Daniel Thomas

See also http://www.icg.port.ac.uk