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Editors: Jacco van Loon and Albert Zijlstra

Editorial

Dear Colleagues,

It is a pleasure to present you the 177$^{\rm th}$ issue of the AGB Newsletter, again a voluminous issue with surely something of your interest.

Note the request for a spectrum of LX Cygni, in the announcement section.

Note also the announcement of this year's Nuclei in the Cosmos conference, in Australia.

The next issue is planned to be distributed around the 1$^{\rm st}$ of May.

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement was suggested by Ehsan Moravveji:

How can one distinguish, observationally, between radial pulsation and convective cells?

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

PN fast winds: Temporal structure and stellar rotation

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To diagnose the time-variable structure in the fast winds of central stars of planetary nebulae (CSPN), we present an analysis of P Cygni line profiles in FUSE satellite far-UV spectroscopic data. Archival spectra are retrieved to form time-series datasets for the H-rich CSPN NGC 6826, IC 418, IC 2149, IC 4593 and NGC 6543. Despite limitations due to the fragmented sampling of the time-series, we demonstrate that in all 5 CSPN the UV resonance lines are variable primarily due to the occurrence of blueward migrating discrete absorption components (DACs). Empirical (SEI) line-synthesis modelling is used to determine the range of fluctuations in radial optical depth, which are assigned to the temporal changes in large-scale wind structures. We argue that DACs are common in CSPN winds, and their empirical properties are akin to those of similar structures seen in the absorption troughs of massive OB stars. Constraints on PN central star rotation velocities are derived from Fast-Fourier Transform analysis of photospheric lines for our target stars. Favouring the causal role of co-rotating interaction regions, we explore connections between normalised DAC accelerations and rotation rates of PN central stars and O stars. The comparative properties suggest that the same physical mechanism is acting to generate large-scale structure in the line-driven winds in the two different settings.

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Discovery of a detached H I gas shell surrounding α Orionis

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We report the detection of the H I line at 21 cm in the direction of α Ori with the Nançay Radiotelescope and with the Very Large Array.
The observations confirm the previous detection of H I emission centered on α Ori, but additionally reveal for the first time a quasi-stationary detached shell of neutral atomic hydrogen $\sim 4'$ in diameter (0.24 pc at a distance of 200 pc). The detached shell appears elongated in a direction opposite to the star's space motion.
A simple model shows that this detached atomic gas shell can result from the collision of the stellar wind from α Ori with the local interstellar medium (ISM). It implies that α Ori has been losing matter at a rate of $\sim 1.2 \times 10^{-6}$ $M_\odot$ yr^{-1} for the past 8×10^4 years.
In addition, we report the detection of atomic hydrogen associated with the far-infrared arc located $6'$ north–east of α Ori, that has been suggested to trace the bow shock resulting from the motion of the star through the ISM. We report also the detection by the Galaxy Evolution Explorer (GALEX) of a far-UV counterpart to this arc.

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Available from arXiv:1203.0255
and from http://aramis.obspm.fr/∼lebertre/paper-alphaOri_MNRAS.pdf

A *Spitzer* Space Telescope study of the debris disks around four SDSS white dwarfs

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We present *Spitzer* Space Telescope data of four isolated white dwarfs that were previously known to harbor circumstellar gaseous disks. IRAC photometry shows a significant infrared excess in all of the systems, SDSS 0738+1835, SDSS 0845+2257, SDSS 1043+0855 and SDSS 1617+1620, indicative of a dusty extension to those disks. The 4.5-μm excesses seen in SDSS 0738+1835, SDSS 0845+2257, and SDSS 1617+1620 are 7.5, 5.7 and 4.5 times the white dwarf contribution, respectively. In contrast, in SDSS 1043+0855, the measured flux density at 4.5 μm is only 1.7 times the white dwarf contribution. We compare the measured IR excesses in the systems to models of geometrically thin, optically thick disks, and find that we are able to match the measured SEDs to within 3σ of the uncertainties, although disks with unfeasibly hot inner dust temperatures generally provide a better fit than those below the dust sublimation temperature. Possible explanations for the dearth of dust around SDSS 1043+0855 are briefly discussed. Including our previous study of SDSS 1228+1040, all five white dwarfs with gaseous debris disks have significant amounts of dust around them. It is evident that gas and dust can coexist around these relatively warm, relatively young white dwarfs.

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Turbulent convection model in the overshooting region: II. Theoretical analysis

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Turbulent convection models are thought to be good tools to deal with the convective overshooting in the stellar interior. However, they are too complex to be applied in calculations of stellar structure and evolution. In order to understand the physical processes of the convective overshooting and to simplify the application of turbulent convection models, a semi-analytic solution is necessary. We obtain the approximate solution and asymptotic solution of the turbulent convection model in the overshooting region, and find some important properties of the convective overshooting: I. The overshooting region can be partitioned into three parts: a thin region just outside the convective boundary with high efficiency of turbulent heat transfer, a power law dissipation region of turbulent kinetic energy in the middle, and a thermal dissipation area with rapidly decreasing turbulent kinetic energy. The decaying indices of the turbulent correlations k, $\overline{u_r' T'}$, and $\overline{T'T'}$ are only determined by the parameters of the TCM, and there is an equilibrium value of the anisotropic degree ω. II. The overshooting length of the turbulent heat flux $\overline{u_r' T'}$ is about $1H_k$ ($H_k = \left|\frac{dr}{dlnk}\right|$). III. The value of the turbulent kinetic energy at the convective boundary $k_{\rm C}$ can be estimated by a method called *the maximum of diffusion*. Turbulent correlations in the overshooting region can be estimated by using $k_{\rm C}$ and exponentially decreasing functions with the decaying indices.

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Alessi 95 and the short period Cepheid SU Cassiopeiae

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The parameters for the newly-discovered open cluster Alessi 95 are established on the basis of available photometric and spectroscopic data, in conjunction with new observations. Colour excesses for spectroscopically-observed B and A-type stars near SU Cas follow a reddening relation described by $E_{U-B}/E_{B-V} = 0.83 + 0.02E_{B-V}$, implying a value of $R = A_V/E_{B-V} \simeq 2.8$ for the associated dust. Alessi 95 has a mean reddening of $E_{B-V}(\mathrm{B0}) = 0.35 \pm 0.02$ s.e., an intrinsic distance modulus of $V_0 - M_V = 8.16 \pm 0.04$ s.e. (± 0.21 s.d.), $d = 429 \pm 8$ pc, and an estimated age of $10^{8.2}$ yr from ZAMS fitting of available *UBV*, CCD *BV*, *NOMAD*, and 2MASS JHK_s observations of cluster stars. SU Cas is a likely cluster member, with an inferred space reddening of $E_{B-V} = 0.33 \pm 0.02$ and a luminosity of $\langle M_V \rangle = -3.15 \pm 0.07$ s.e., consistent with overtone pulsation ($P_\mathrm{FM} = 2^\mathrm{d}.75$), as also implied by the Cepheid's light curve parameters, rate of period increase, and *Hipparcos* parallaxes for cluster stars. There is excellent agreement of the distance estimates for SU Cas inferred from cluster ZAMS fitting, its pulsation parallax derived from the infrared surface brightness technique, and *Hipparcos* parallaxes, which all agree to within a few percent.

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Chemical mixing by turbulent convection in the overshooting region below the convective envelope of RGB stars

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Based on the turbulent convection model (TCM), we investigate chemical mixing in the bottom overshooting region of the convective envelope of intermediate-mass stars, focusing on its influence on the formation and extension of blue loops in the Hertzsprung–Russell (HR) diagram. A diffusive mixing model is adopted during the Red Giant Branch (RGB) phase. The properties of the blue loop are changed by modification of the element profiles above the H-burning shell, which results from the incomplete mixing in the bottom overshooting region when the stellar model evolves up along the RGB. Such modification of the element profiles will lead to an increase of opacity in the region just above the H-burning shell and a decrease of opacity in the outer homogeneous convection zone, which will result in a quick decrease of the H-shell nuclear luminosity $\mathrm{L_H}$ when the stellar model evolves from the RGB tip to its bottom and, finally, a much weaker and smaller convection zone will be obtained in the stellar envelope. This helps to form a longer blue loop. The extension of the blue loop is very sensitive to the parameters ($\mathrm{C_X}$ and α_TCM) of the diffusive mixing model and of the TCM. The results mainly show that: 1) comparing the results of the classical model with the mixing-length theory, the lengths of the obtained blue loops with different combinations of the values of $\mathrm{C_X}$ and α_TCM are all increased and the length of the blue loop increases with the values of parameters $\mathrm{C_X}$ and α_TCM; 2) the diffusive mixing model can significantly extend the time of stellar models lingering on the blue side of the HR diagram, even though the length of the blue loop for the 7 $\mathrm{M_\odot}$ star has a less prominent difference between the classical and

diffusive mixing model; 3) both the observations referring to the location of the Cepheid instability strip and the number ratio NB/NR of blue to red evolved stars in the Galactic open clusters can confine the two parameters in a range of $0.5 \leq \alpha_{\rm TCM} \leq 0.9$ and $10^{-5} \leq C_{\rm X} \leq 10^{-4}$ for the model of 5 $M_\odot$. However, for the case of the 7 $M_\odot$ star, there seems to be no such definite range to even only account for the observed number ratio NB/NR. In any case, our results based on the diffusive mixing model are on the whole in accordance with not only other theoretical ones but also the observations.

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Evolution of the symbiotic nova PU Vul – outbursting white dwarf, nebulae, and pulsating red giant companion

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We present a composite light-curve model of the symbiotic nova PU Vul (Nova Vulpeculae 1979) that shows a long-lasted flat optical peak followed by a slow decline. Our model light-curve consists of three components of emission, i.e. an outbursting white dwarf (WD), its M-giant companion, and nebulae. The WD component dominates in the flat peak while the nebulae dominate after the photospheric temperature of the WD rises to $\log T$ (K) $\gtrsim$4.5, suggesting its WD origin. We analyze the 1980 and 1994 eclipses to be total eclipses of the WD occulted by the pulsating M-giant companion with two sources of the nebular emission; one is an unocculted nebula of the M-giant's cool-wind origin and the other is a partially occulted nebula associated to the WD. We confirmed our theoretical outburst model of PU Vul by new observational estimates, that spanned 32 yr, of the temperature and radius. Also our eclipse analysis confirmed that the WD photosphere decreased by two orders of magnitude between the 1980 and 1994 eclipses. We obtain the reddening $E(B-V) \sim 0.3$ and distance to PU Vul $d \sim 4.7$ kpc. We interpret the recent recovery of brightness in terms of eclipse of the hot nebula surrounding the WD, suggesting that hydrogen burning is still going on. To detect supersoft X-rays, we recommend X-ray observations around June 2014 when absorption by neutral hydrogen is minimum.

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Reconciling the emission mechanism discrepancy in Mira's tail, and its evolution in an interface with shear

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GALEX observations of the Mira AB binary system revealed a surrounding structure that has been successfully hydrodynamically interpreted as a bow shock and tail of ram-pressure-stripped material. Even the narrow tail, initially difficult to model, has been understood as the effect of the passage of Mira from a warm neutral medium into a hot, low-density medium, postulated to be the Local Bubble. However, no model to date has explained the observed kink and associated general curvature of the tail. We test the hypothesis that before entering the Local Bubble, Mira was travelling through a shear flow with approximately 1/3 Mira's own velocity at an angle of $\sim 30^\circ$ to Mira's proper motion. The hypothesis reproduces the kinked nature of Mira's tail and predicts recompression and reheating of the tail material to the same or greater levels of density and temperature predicted in the shock. This provides a heat

source for the FUV emission, allowing for an extended lifetime of the FUV emission in line with other estimates of the age of the tail. The uniqueness of Mira's situation implies that the chances of observing other FUV tails behind AGB stars is highly unlikely.

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The historical light curve of the symbiotic star AG Draconis: intense, magnetically induced cyclic activity

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We analyse the historical optical light curve of the symbiotic system AG Draconis, covering the last 120 years. During the first 31 years the brightness of the star has not been varying by more than 0.1 mag. A weak periodic signal with the binary period of the system of $\sim$ 550 d can be detected in this section of the light curve, as well as in all other later quiescence sections of it.
Around the year 1922 the quiescence brightness of the star increased by 0.29 mag. Since then the star's photometric history is marked by a series of brightness fluctuations with an amplitude of 1–2 mag and a typical duration of 100–200 d. The time intervals between outbursts are integral numbers of the period 373.5 d. The outbursts are grouped in 6 dense clusters, each one lasting some 1500 d, that are well separated from one another along the time axis with a quasi periodicity of 5300 d.
We suggest that the outbursts of the system are triggered by episodes of intense mass outflow from the atmosphere of the cool star onto the environment of the hot component. The 373.5 d cycle is the length of a "day" on the surface of the giant that rotates in retrograde direction with a sidereal period of 1160 d. A weak signal with this periodicity is also present in the light curve. The modulation of mass transfer in the system is a combined effect of a dipole magnetic field of the giant star and the tides induced in its atmosphere by its binary companion. The 5300 d quasi period is that of a solar-like magnetic dynamo process that operates in the outer layers of the giant. The combined effect of the 5300 d and 373.5 d cycles induces a second mode of pulsation of the giant star with the period of 350 d. AG Dra is the 5$^{\rm th}$ symbiotic system that shows in its historical light curve this type of intense magnetic and magnetically induced activity.

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Constraints on the lifetimes of disks resulting from tidally destroyed rocky planetary bodies

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Spitzer IRAC observations of 15 metal-polluted white dwarfs reveal infrared excesses in the spectral energy distributions of HE 0110−5630, GD 61, and HE 1349−2305. All three of these stars have helium-dominated atmospheres, and their infrared emissions are consistent with warm dust produced by the tidal destruction of (minor) planetary bodies. This study brings the number of metal-polluted, helium and hydrogen atmosphere white dwarfs surveyed with IRAC to

53 and 38 respectively. It also nearly doubles the number of metal-polluted helium-rich white dwarfs found to have closely orbiting dust by *Spitzer*. From the increased statistics for both atmospheric types with circumstellar dust, we derive a typical disk lifetime of $\log t_{\rm disk}({\rm yr}) = 5.6 \pm 1.1$ (ranging from 3×10^4–5×10^6 yr). This assumes a relatively constant rate of accretion over the timescale where dust persists, which is uncertain. We find that the fraction of highly metal-polluted helium-rich white dwarfs that have an infrared excess detected by *Spitzer* is only 23 per cent, compared to 48 per cent for metal-polluted hydrogen-rich white dwarfs, and we conclude from this difference that the typical lifetime of dusty disks is somewhat shorter than the diffusion time scales of helium-rich white dwarf. We also find evidence for higher time-averaged accretion rates onto helium-rich stars compared to the instantaneous accretion rates onto hydrogen-rich stars; this is an indication that our picture of evolved star-planetary system interactions is incomplete. We discuss some speculative scenarios that can explain the observations.

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The pulsation period of the hot hydrogen-deficient star MV Sgr

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MV Sgr is a hot, hydrogen-deficient star which has undergone R CrB fadings. We have used self-correlation analysis and Fourier analysis of CCD V photometry in the AAVSO International Database to identify a period of 8.0 days in this star; the amplitude is about 0.03 mag. The variability is most likely due to pulsation.

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The filamentary multi-polar Planetary Nebula NGC 5189

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We present a set of optical and infrared images combined with long-slit, medium and high dispersion spectra of the southern planetary nebula (PN) NGC 5189. The complex morphology of this PN is puzzling and has not been studied in detail so far. Our investigation reveals the presence of a new dense and cold infrared torus (alongside the optical one) which probably generated one of the two optically seen bipolar outflows and which might be responsible for the twisted appearance of the optical torus via an interaction process. The high-resolution MES–AAT spectra clearly show the presence of filamentary and knotty structures as well as three expanding bubbles. Our findings therefore suggest that NGC 5189 is a quadrupolar nebula with multiple sets of symmetrical condensations in which the interaction of outflows has determined the complex morphology.

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Direct imaging of a massive dust cloud around R Coronae Borealis

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We present recent polarimetric images of the highly variable star R CrB using ExPo and archival WFPC2 images from the HST. We observed R CrB during its current dramatic minimum where it decreased more than 9 mag due to the formation of an obscuring dust cloud. Since the dust cloud is only in the line-of-sight, it mimics a coronograph allowing the imaging of the star's circumstellar environment. Our polarimetric observations surprisingly show another scattering dust cloud at approximately 1.″3 or 2000 AU from the star. We find that to obtain a decrease in the stellar light of 9 mag and with 30% of the light being reemitted at infrared wavelengths (from R CrB's SED) the grains in R CrB's circumstellar environment must have a very low albedo of approximately 0.07%. We show that the properties of the dust clouds formed around R CrB are best fitted using a combination of two distinct populations of grains size. The first are the extremely small 5 nm grains, formed in the low density continuous wind, and the second population of large grains (~ 0.14 μm) which are found in the ejected dust clouds. The observed scattering cloud, not only contains such large grains, but is exceptionally massive compared to the average cloud.

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Probing the core structure and evolution of red giants using gravity-dominated mixed modes observed with *Kepler*

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There are now more than 22 months of long-cadence data available for thousands of red giants observed with the *Kepler* space mission. Consequently, we are able to clearly resolve fine details in their oscillation spectra and see many components of the mixed modes that probe the stellar core. We report for the first time a parametric fit to the pattern of the $\ell = 1$ mixed modes in red giants, which is a powerful tool to identify gravity-dominated mixed modes. With these modes, which share the characteristics of pressure and gravity modes, we are able to probe directly the helium core and the surrounding shell where hydrogen is burning. We propose two ways for describing the so-called mode bumping that affects the frequencies of the mixed modes. Firstly, a phenomenological approach is used to describe the main features of the mode bumping. Alternatively, a quasi-asymptotic mixed-mode relation provides a powerful link between seismic observations and the stellar interior structure. We used period échelle diagrams to emphasize the detection of the gravity-dominated mixed modes. The asymptotic relation for mixed modes is confirmed. It allows us to measure the gravity-mode period spacings in more than two hundred red giant stars. The identification of the gravity-dominated mixed modes allows us to complete the identification of all major peaks in a red giant oscillation spectrum, with significant consequences for the true identification of $\ell = 3$ modes, of $\ell = 2$ mixed modes, for the mode widths and amplitudes, and for the $\ell = 1$ rotational splittings. The accurate measurement of the gravity-mode period spacing provides an effective probe of the inner, g-mode cavity. The derived value of the coupling coefficient between the cavities is different for red giant branch and clump stars. This provides a probe of the hydrogen-shell burning region that surrounds the helium core. Core contraction as red giants ascend the red giant branch can be explored using the variation of the gravity-mode spacing as a function of the mean large separation.

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Stellar lifetime and ultraviolet properties of the old metal-rich Galactic open cluster NGC 6791: a pathway to understand the UV upturn of elliptical galaxies

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The evolutionary properties of the old metal-rich Galactic open cluster NGC 6791 are assessed, based on deep UB photometry and 2MASS JK data. For 4739 stars in the cluster, bolometric luminosity and effective temperature have been derived from theoretical $(U-B)$ and $(J-K)$ color fitting. The derived H–R diagram has been matched with the UVBLUE grid of synthetic stellar spectra to obtain the integrated SED of the system, together with a full set UV (Fanelli) and optical (Lick) narrow-band indices. The total bolometric magnitude of NGC 6791 is $M_{\rm bol} = -6.29$, with a color $(B-V) = 0.97$. The cluster appears to be a fairly good proxy of standard elliptical galaxies, although with significantly bluer infrared colors, a shallower 4000 Å Balmer break, and a lower Mg_2 index. The confirmed presence of a dozen hot stars, along their EHB evolution, leads the cluster SED to consistently match the properties of the most active UV-upturn galaxies, with $1.7 \pm 0.4\%$ of the total bolometric luminosity emitted shortward of 2500 Å. The cluster Helium abundance results $Y_{6791} = 0.30 \pm 0.04$, while the Post-MS implied stellar lifetime from star number counts fairly agrees with the theoretical expectations from both the Padova and BASTI stellar tracks. A Post-MS fuel consumption of 0.43 ± 0.01 $M_\odot$ is found for NGC 6791 stars, in close agreement with the estimated mass of cluster He-rich white dwarfs. Such a tight figure may lead to suspect that a fraction of the cluster stellar population does actually not reach the minimum mass required to effectively ignite He in the stellar core.

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Medium-resolution s-process element survey of 47 Tuc giant stars

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Medium-resolution ($R \sim 6,500$) spectra of 97 giant stars in the globular cluster 47 Tucanæ (47 Tuc) have been used to derive the C and N abundance sensitive index, δC, and to infer abundances of several key elements, Fe, Na, Si, Ca, Zr and Ba for a sample of 13 of these stars with similar $T_{\rm eff}$ and $\log g$. These stars have stellar properties similar to the well-studied 47 Tuc giant star, Lee 2525, but with a range of CN excess (δC) values which are a measure of the CN abundance. The δC index is shown to be correlated with Na abundance for this sample, confirming previous studies. The Fe, Ca, Si and the light- and heavy-s process (slow neutron capture) elements, Zr and Ba respectively, have a narrow range of abundance values in these stars, indicative of a homogeneous abundance within this population of stars. The constancy of many element abundances (Fe, Si, Ca, Zr, Ba) and the δC and Na abundance correlation could imply that there has been a second era of star formation in this cluster that has revealed the products of CNO cycle burning via hot bottom burning (depletion of C, enhancement of N and the production of Na for high δC population). But there is no overall metallicity change across the range of δC values at a given position in the HR diagram that has been seen in some other globular clusters.

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Detection of C_{60} in embedded young stellar objects, a Herbig Ae/Be star and an unusual post-AGB star

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The first detection of the C_{60} (Buckminsterfullerene) molecule in massive embedded young stellar objects (YSOs) is reported. Observations with *Spitzer* IRS reveal the presence of C_{60} in YSOs ISOGAL-P J174639.6−284126 and SSTGC 372630 in the Central Molecular Zone in the Galactic centre, and in a YSO candidate, 2MASS J06314796 +0419381, in the Rosette nebula. The first detection of C_{60} in a Herbig Ae/Be star, HD 97300, is also reported. These observations extend the range of astrophysical environments in which C_{60} is found to YSOs and a pre-main sequence star. C_{60} excitation and formation mechanisms are discussed in the context of these results, together with its presence and processes in post-AGB objects such as HR 4049.

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Abundances of PNe in the outer disk of M 31

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We present spectroscopic observations and chemical abundances of 16 planetary nebulae (PNe) in the outer disk of M 31. The [O III] 4363 line is detected in all objects, allowing a direct measurement of the nebular temperature essential for accurate abundance determinations. Our results show that the abundances in these M 31 PNe display the same correlations and general behaviors as Type II PNe in the Milky Way Galaxy. We also calculate photoionization models to derive estimates of central star properties. From these we infer that our sample PNe, all near the peak of the Planetary Nebula Luminosity Function, originated from stars near 2 $M_{\odot}$. Finally, under the assumption that these PNe are located in M 31's disk, we plot the oxygen abundance gradient, which appears shallower than the gradient in the Milky Way.

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The S^{4}G perspective on circumstellar dust extinction of AGB stars in M 100

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We examine the effect of circumstellar dust extinction on the near-IR contribution of asymptotic giant branch (AGB) stars in intermediate-age clusters throughout the disk of M 100. For our sample of 17 AGB-dominated clusters we extract optical-to-mid-IR SEDs and find that NIR brightness is coupled to the mid-IR dust emission in such a way that a significant reduction of AGB light, of up to 1 mag in K-band, follows from extinction by the dust shell formed during this stage. Since the dust optical depth varies with AGB chemistry (C-rich or O-rich), our results suggest that the contribution of AGB stars to the flux from their host clusters will be closely linked to the metallicity and the progenitor mass of the AGB star, to which dust chemistry and mass-loss rate are sensitive. Our sample of clusters – each the analogue of a $\sim$ 1 Gyr old post-starburst galaxy – has implications within the context of mass and age estimation via SED modelling at high z: we find that the average ~ 0.5 mag extinction estimated here may be sufficient to reduce the AGB contribution in (rest-frame) K-band from $\sim 70\%$, as predicted in the latest generation of synthesis models, to $\sim 35\%$. Our technique for selecting AGB-dominated clusters in nearby galaxies promises to be effective for discriminating the uncertainties associated with AGB stars in intermediate-age populations that plague age and mass estimation in high-z galaxies.

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IC 4663: The first unambiguous [WN] Wolf–Rayet central star of a planetary nebula

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We report on the serendipitous discovery of the first central star of a planetary nebula (PN) that mimics the helium- and nitrogen-rich WN sequence of massive Wolf–Rayet (WR) stars. The central star of IC 4663 (PN G 346.2−08.2) is dominated by broad He II and N V emission lines which correspond to a [WN3] spectral type. Unlike previous [WN] candidates, the surrounding nebula is unambiguously a PN. At an assumed distance of 3.5 kpc, corresponding to a stellar luminosity of 4000 $L_{\odot}$, the $V = 16.9$ mag central star remains 4–6 mag fainter than the average luminosity of massive WN3 stars even out to an improbable $d = 8$ kpc. The nebula is typical of PNe with an elliptical morphology, a newly discovered Asymptotic Giant Branch (AGB) halo, a relatively low expansion velocity ($v_{\rm exp} = 30$ km s^{-1}) and a highly ionised spectrum with an approximately Solar chemical abundance pattern. The [WN3] star is hot enough to show Ne VII emission ($T_{\star} = 140 \pm 20$ kK) and exhibits a fast wind ($v_{\infty} = 1900$ km s^{-1}), which at $d = 3.5$ kpc would yield a clumped mass-loss rate of $\dot{M} = 1.8 \times 10^{-8}$ M$_{\odot}$ yr^{-1} with a small stellar radius ($R_{\star} = 0.11$ R$_{\odot}$). Its atmosphere consists of helium (95%), hydrogen (< 2%), nitrogen (0.8%), neon (0.2%) and oxygen (0.05%) by mass. Such an unusual helium-dominated composition cannot be produced by any extant scenario used to explain the H-deficiency of post-AGB stars. The O(He) central stars share a similar composition and the discovery of IC 4663 provides the first evidence for a second He-rich/H-deficient post-AGB evolutionary sequence [WN]→O(He). This suggests there is an alternative mechanism responsible for producing the majority of H-deficient post-AGB stars that may possibly be expanded to include other He-rich/H-deficient stars such as R Coronae Borealis stars and AM Canum Venaticorum stars. The origin of the unusual composition of [WN] and O(He) central stars remains unexplained.

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IRAS 11472−0800: an extremely depleted pulsating binary post-AGB star

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We focus here on one particular and poorly studied object, IRAS 11472−0800. It is a highly evolved post-Asymptotic Giant Branch (post-AGB) star of spectral type F, with a large infrared excess produced by thermal emission of circumstellar dust. We deploy a multi-wavelength study which includes the analyses of optical and IR spectra as well as a variability study based on photometric and spectroscopic time-series. The spectral energy distribution (SED) properties as well as the highly processed silicate N-band emission show that the dust in IRAS 11472−0800 is likely trapped in a stable disc. The energetics of the SED and the colour variability show that our viewing angle is close to edge-on and that the optical flux is dominated by scattered light. With photospheric abundances of [Fe/H] = −2.7 and [Sc/H] = −4.2, we discovered that IRAS 11472−0800 is one of the most chemically-depleted objects known to date. Moreover, IRAS 11472−0800 is a pulsating star with a period of 31.16 days and a peak-to-peak amplitude of

0.6 mag in V. The radial velocity variability is strongly influenced by the pulsations, but the significant cycle-to-cycle variability is systematic on a longer time scale, which we interpret as evidence for binary motion. We conclude that IRAS 11472−0800 is a pulsating binary star surrounded by a circumbinary disc. The line-of-sight towards the object lies close the the orbital plane making that the optical light is dominated by scattered light. IRAS 11472−0800 is one of the most chemically-depleted objects known so far and links the dusty RV Tauri stars to the non-pulsating class of strongly depleted objects.

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"Distance mapping" and the 3-D structure of BD +30°3639

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BD +30°3639 is a member of a group of uncommon planetary nebula with Wolf–Rayet central star and higher expansion velocities in [O III] than in [N II] lines. Images and high-resolution spectra from the literature are used in order to construct a 3-D model of the nebula using the morpho-kinematic code SHAPE. We find that two homologous expansion laws are needed for the [N II] and [O III] shell. We conclude that the internal velocity field of BD +30°3639 decreases with the distance from the central star at least between the [O III] and [N II] shells. A cylindrical velocity component is used to replicate the high-speed bipolar collimated outflows. We also present a new kinematic analysis technique called "distance mapping". It uses the observed proper motion vectors and the 3-D velocity field to generate maps that can be used as a constraint to the morpho-kinematic modeling with SHAPE as well as improve the accuracy for distance determination. It is applied to BD +30°3639 using 178 internal proper motion vectors from Li et al. (2002) and our 3-D velocity field to determine a distance of 1.52 ± 0.21 kpc. Finally, we find evidence for an interaction between the eastern part of nebula and the ambient H_2 molecular gas.

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Polarization of thermal molecular lines in the envelope of IK Tau

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Molecular line polarization is a unique source of information about the magnetic fields and anisotropies in the circumstellar envelopes of evolved stars. Here we present the first detection of thermal CO ($J = 2$–1) and SiO ($J = 5$–4, $v = 0$) polarization, in the envelope of the asymptotic giant branch star IK Tau. The observed polarization direction does not match predictions for circumstellar envelope polarization induced only by an anisotropic radiation field. Assuming that the polarization is purely due to the Goldreich–Kylafis effect, the linear polarization direction is defined by the magnetic field as even the small Zeeman splitting of CO and SiO dominates the molecular collisional and spontaneous emission rates. The polarization was mapped using the Submillimeter Array (SMA) and is predominantly north–south. There is close agreement between the CO and SiO observations, even though the CO polarization arises in the circumstellar envelope at ~ 800 AU and the SiO polarization at < 250 AU. If the polarization indeed traces the magnetic field, we can thus conclude that it maintains a large-scale structure throughout the circumstellar

envelope. We propose that the magnetic field, oriented either east–west or north–south is responsible for the east–west elongation of the CO distribution and asymmetries in the dust envelope. In the future, the Atacama Large Millimeter/submillimeter Array will be able to map the magnetic field using CO polarization for a large number of evolved stars.

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A large group of AGB stars in the disk of M 31: A missing piece of the puzzle?

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The properties of a stellar grouping that is $\sim$ 3.5 kpc to the north east of the center of M 31 is examined. This structure has (1) a surface brightness that is lower than the surrounding disk, (2) a more-or-less round appearance, (3) a size of $\sim 300''$ ($\sim$ 1 kpc), and (4) an integrated brightness $K = 6.5$. It is populated by stars with ages > 100 Myr and J–K colors that tend to be bluer than those of stars in the surrounding disk. Comparisons with model luminosity functions suggest that the star formation rate in this object has changed twice in the past few hundred Myr. Fitting a Sersic function to the light profile reveals a power-law index and effective surface brightness that are similar to those of dwarf galaxies with the same integrated brightness. Two possible origins for this object are considered: (1) it is a heretofore undiscovered satellite of M 31 that is seen against/in/through the M 31 disk, or (2) it is a fossil star-forming region in the M 31 disk.

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Morpho-kinematic analysis of the point-symmetric, bipolar planetary nebulae Hb 5 and K 3-17, a pathway to poly-polarity

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The kinematics of the bipolar planetary nebulae Hb 5 and K 3-17 are investigated in detail by means of a comprehensive set of spatially resolved high spectral resolution, long-slit spectra. Both objects share particularly interesting characteristics, such as a complex filamentary, rosette-type nucleus, axial point-symmetry and very fast bipolar outflows. The kinematic information of Hb 5 is combined with *Hubble* Space Telescope imagery to construct a detailed three-dimensional model of the nebula using the code SHAPE. The model shows that the large scale lobes are growing in a non-homologous way. The filamentary loops in the core are proven to actually be secondary lobes emerging from what appears to be a randomly punctured, dense, gaseous core and the material that forms the point symmetric structure flows within the lobes with a distinct kinematic pattern and its interaction with the lobes has had a shaping effect on them. Hb 5 and K 3-17 may represent a class of fast evolving planetary nebulae that will develop poly-polar characteristics once the nebular core evolves and expands.

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Post-AGB stars in the SMC as tracers of stellar evolution: the extreme s-process enrichment of the 21 μm star J 004441.04−732136.4

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Context: This paper is part of a larger project in which we want to focus on the still poorly understood AGB third dredge-up processes and associated s-process nucleosynthesis.
Aims: We confront accurate spectral abundance analyses of post-AGB stars in both the LMC and SMC, to state-of-the-art AGB model predictions. With this comparison we aim at improving our understanding of the 3$^{\rm rd}$ dredge-up phenomena and their dependencies on initial mass and metallicity.
Methods: Because of the well constrained distance with respect to Galactic post-AGB stars, we choose an extra-galactic post-AGB star for this contribution, namely the only known 21 μm object of the Small Magellanic Cloud (SMC): J 004441.04−732136.4. We used optical UVES spectra to perform an accurate spectral abundance analysis. With photometric data of multiple catalogues we construct a spectral energy distribution and perform a variability analysis. The results are then compared to predictions of tailored theoretical chemical AGB evolutionary models for which we used two evolution codes.
Results: Spectral abundance results reveal J 004441.04−732136.4 to be one of the most s-process enriched objects found up to date, while the photospheric C/O ratio of 1.9±0.7, shows the star is only modestly C-rich. J 004441.04−732136.4 also displays a low [Fe/H] = -1.34 ± 0.32, which is significantly lower than the mean metallicity of the SMC. From the SED, a luminosity of 7600 ± 200 L$_\odot$ is found, together with $E(B-V) = 0.64 \pm 0.02$. According to evolutionary post-AGB tracks, the initial mass should be ~ 1.3 M$_\odot$. The photometric variability shows a clear period of 97.6 ± 0.3 days. The detected C/O as well as the high s-process overabundances (e.g., [Y/Fe] = 2.15, [La/Fe] = 2.84) are hard to reconcile with the predictions. The chemical models also predict a high Pb abundance, which is not compatible with the detected spectrum, and a very high ^{12}C/^{13}C, which is not yet constrained by observations. The predictions are only marginally dependent on the evolution codes used.
Conclusions: By virtue of their spectral types, favourable bolometric corrections as well as their constrained distances, post-AGB stars in external galaxies offer unprecedented tests to AGB nucleosynthesis and dredge-up predictions. We focus here on one object J 004441.04−732136.4, which is the only known 21 μm source of the SMC. We show that our theoretical predictions match the s- process distribution, but fail in reproducing the detected high overabundances and predict a high Pb abundance which is not detected. Additionally, there remain serious problems in explaining the observed pulsational properties of this source.

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Global models of runaway accretion in white dwarf debris disks

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A growing sample of young white dwarfs (WDs) with metal-enriched atmospheres are accompanied by excess infrared emission, indicating that they are encircled by a compact dusty disk of solid debris. Such 'WD debris disks' are thought to originate from the tidal disruption of asteroids or other minor bodies. However, the precise mechanism(s) responsible for transporting matter from the disruption radius to the WD surface remains unclear, especially in those systems with the highest inferred metal accretion rates $\dot{M}_Z \sim 10^8$–10^{10} g s^{-1}, which cannot be explained by Poynting–Robertson (PR) drag alone. Here we present global time-dependent calculations of the coupled evolution of the gaseous and solid components of WD debris disks. Solids transported inwards (initially due to PR drag) sublimate at tens

of WD radii, producing a source of gas that both accretes onto the WD surface and viscously spreads outwards in radius, where it overlaps with the solid disk. Our calculations show that if the aerodynamic coupling between the solids and gaseous disks is sufficiently strong (and/or the gas viscosity sufficiently weak), then gas builds up near the sublimation radius faster than it can viscously spread away. Since the rate of drag-induced solid accretion increases with gas density, this results in a runaway accretion process, as predicted by Rafikov, during which the WD accretion rate reaches values orders of magnitude higher than can be achieved by PR drag alone, consistent with the highest measured values of $\dot{M}_Z$. We explore the evolution of WD debris disks across a wide range of physical conditions and describe the stages of the runaway process in detail. We also calculate the predicted distribution of observed accretion rates $\dot{M}_Z$, finding reasonable agreement with the current sample. Although the conditions necessary for runaway accretion are at best marginally satisfied given the minimal level of aerodynamic drag between circular gaseous and solid disks, the presence of other stronger forms of solid-gas coupling – such as would result if the gaseous disk is only mildly eccentric – substantially increase the likelihood of runaway accretion.

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SiO maser emission from red supergiants across the Galaxy: I. Targets in massive star clusters

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Aims: Red supergiants (RSGs) are among the most luminous of all stars, easily detectable in external galaxies, and may ideally serve as kinematic tracers of Galactic structure. Some RSGs are surrounded by circumstellar envelopes detectable by their dust and molecular and, in particular, maser emission. This study consists of a search for maser emission from silicon monoxide (SiO) toward a significant number of RSGs that are members of massive stellar clusters, many of which have only recently been discovered. Further, we aim to relate the occurrence of maser action to properties of the host stars.
Methods: Using the IRAM 30 meter telescope, we searched for maser emission in the $J = 2$–1 rotational transition within the first vibrationally excited state of SiO toward a sample of 88 RSGs.
Results: With an average r.m.s. noise level of 0.25 Jy, we detected maser emission in 15% of the sample, toward most of the sources for the first time in this transition. The peak of the emission provides accurate radial velocities for the RSGs. The dependence of the detection rate on infrared colors supports a radiative pumping mechanism for the SiO masers.

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CO observations of water-maser post-AGB stars and detection of a high-velocity outflow in IRAS 15452−5459

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Many aspects of the evolutionary phase in which Asymptotic Giant Branch stars (AGB stars) are in transition to become Planetary Nebulae (PNe) are still poorly understood. An important question is how the circumstellar envelopes

of AGB stars switch from spherical symmetry to the axially symmetric structures frequently observed in PNe. In many cases there is clear evidence that the shaping of the circumstellar envelopes of PNe is linked to the formation of jets/collimated winds and their interaction with the remnant AGB envelope. Because of the short evolutionary time, objects in this phase are rare, but their identification provides valuable probes for testing evolutionary models. We have observed (sub)millimeter CO rotational transitions with the APEX telescope in a small sample of stars hosting high-velocity OH and water masers. These targets are supposed to have recently left the AGB, as indicated by the presence of winds traced by masers, with velocities larger than observed during that phase. We have carried out observations of several CO lines, ranging from $J = 2$–1 up to $J = 7$–6. In IRAS 15452−5459 we detect a fast molecular outflow in the central region of the nebula and estimate a mass-loss rate between 1.2×10^{-4} $M_\odot$ yr^{-1} (assuming optically thin emission) and 4.9×10^{-4} $M_\odot$ yr^{-1} (optically thick emission). We model the SED of this target taking advantage of our continuum measurement at 345 GHz to constrain the emission at long wavelengths. For a distance of 2.5 kpc, we estimate a luminosity of 8000 $L_\odot$ and a dust mass of ~ 0.01 $M_\odot$. Through the flux in the [C II] line (158 μm), we calculate a total mass of about 12 $M_\odot$ for the circumstellar envelope, but the line is likely affected by interstellar contamination.

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Fundamental properties and atmospheric structure of the red supergiant VY CMa based on VLTI/AMBER spectro-interferometry

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We investigate the atmospheric structure and fundamental properties of the red supergiant VY CMa. We obtained near-infrared spectro-interferometric observations of VY CMa with spectral resolutions of 35 and 1500 using the AMBER instrument at the VLTI. The visibility data indicate the presence of molecular layers of water vapor and CO in the extended atmosphere with an asymmetric morphology. The uniform disk diameter in the water band around 2.0 μm is increased by $\sim 20\%$ compared to the near-continuum bandpass at 2.20–2.25 μm, and in the CO band at 2.3–2.5 μm it is increased by up to $\sim 50\%$. The closure phases indicate relatively small deviations from point symmetry close to the photospheric layer, and stronger deviations in the extended H_2O and CO layers, peaking at the positions of the strong CO band-heads. Making use of the high spatial and spectral resolution, a near-continuum bandpass can be isolated from contamination by molecular and dusty layers, and the Rosseland-mean photospheric angular diameter is estimated to 11.3 ± 0.3 mas. Together with recent high-precision estimates of the distance and the spectro-photometry, this estimate corresponds to a radius of 1420 ± 120 $R_\odot$ and an effective temperature of 3490 ± 90 K. VY CMa exhibits asymmetric, possibly clumpy, atmospheric layers of H_2O and CO, which are not co-spatial, within a larger elongated dusty envelope. Our revised fundamental parameters put VY CMa close to the Hayashi limit of recent evolutionary tracks of initial mass 25 $M_\odot$ with rotation or 32 $M_\odot$ without rotation.

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Lithium abundances in CEMP stars

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Carbon-enhanced metal-poor (CEMP) stars are believed to show the chemical imprints of more massive stars ($M \gtrsim 0.8$ $M_\odot$) that are now extinct. In particular, it is expected that the observed abundance of Li should deviate in these stars from the standard Spite lithium plateau. We study here a sample of 11 metal-poor stars and a double-lined spectroscopic binary with $-1.8 <$ [Fe/H] < -3.3 observed with VLT/UVES spectrograph. Among these 12 metal-poor stars, there are 8 CEMP stars for which we measure or constrain the Li abundance. In contrast to previous arguments, we demonstrate that an appropriate regime of dilution permits the existence of "Li-Spite plateau and C-rich" stars, whereas some of the "Li-depleted and C-rich" stars call for an unidentified additional depletion mechanism that cannot be explained by dilution alone. We find evidence that rotation is related to the Li depletion in some CEMP stars. Additionally, we report on a newly recognized double-lined spectroscopic binary star in our sample. For this star, we develop a new technique from which estimates of stellar parameters and luminosity ratios can be derived based on a high-resolution spectrum alone, without the need for input from evolutionary models.

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Recent photometry of symbiotic stars – XIII

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We present new multicolour ($UBVR_cI_c$) photometric observations of classical symbiotic stars, EG And, Z And, BF Cyg, CH Cyg,CI Cyg, V1329 Cyg, TX CVn, AG Dra, Draco C1, AG Peg and AX Per, carried out between 2007.1 and 2011.9. The aim of this paper is to present new data of our monitoring programme, to describe the main features of their light curves and to point problems for their future investigation. The data were obtained by the method of the classical photoelectric and CCD photometry.

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Bubbles and knots in the kinematical structure of the bipolar planetary nebula NGC 2818

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High-resolution *Hubble* Space Telescope (HST) archive imaging and high-dispersion spectroscopy are used to study the complex morphological and kinematical structure of the planetary nebula, NGC 2818. We analyze narrow band Hα, [O III], [N II], [S II] and He II images, addressing important morphological features. Ground-based longslit échelle spectra were obtained crossing NGC 2818 at five different positions to precisely determine kinematical features in the structure of the nebula. A distance of 2.5 kpc (Van de Steene & Zijlstra 1995) was used to determine physical scales. Constructing models to fit the data with modern computational tools, we find NGC 2818 is composed by: (1) a non-uniform bipolar structure with a semi-major axis of 0.92 pc (75″), possibly deformed by the stellar wind, (2) a 0.17 pc (14″) diameter central region, which is potentially the remnant of an equatorial enhancement, and (3) a great number of cometary knots. These knots are preferentially located inside a radius of 0.24 pc (20″) around the central star. The major axis of the main structure is oriented at $i \simeq 60°$ with respect to the line-of-sight and at $PA = +89°$ on the plane of the sky. Expansion velocities of this nebula are $v_{\rm pol} = 105$ km s^{-1} and $v_{\rm eq} = 20$ km s^{-1}, which lead to our estimate of the kinematical age of $\tau_{\rm k} \simeq 8,400 \pm 3,400$ yr (assuming homologous expansion). Our observations do not support the idea that high velocity collimated ejections are responsible for the formation of microstructures inside the nebula. We determine the systemic velocity of NGC 2818 to be $v_{\rm hel} = +26 \pm 2$ km s^{-1}.

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Probing the mass and structure of the Ring Nebula in Lyra with SOFIA/GREAT observations of the [C II] 158 μm line

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We have obtained new velocity-resolved spectra of the [C II] 158 μm line towards the Ring Nebula in Lyra (NGC 6720), one of the best-studied planetary nebulae, in order to probe its controversial 3-dimensional structure and to estimate the mass of circumstellar material in this object. We used the Terahertz receiver GREAT aboard the SOFIA airborne telescope to obtain the [C II] spectra at eight locations within and outside the bright optical ring of NGC 6720. Emission was detected at all positions except for the most distant position along the nebula's minor axis, and generally covers a broad velocity range, $\Delta v \sim 50$ km s^{-1} (FWZI), except at a position along the major axis located just outside the optical ring, where it is significantly narrower ($\Delta v \sim 25$ km s^{-1}). The one narrow spectrum appears to be probing circumstellar material lying outside the main nebular shell that has not been accelerated by past fast wind episodes from the central star, and therefore most likely comes from equatorial and/or low-latitude regions of this bipolar nebula. Along lines-of-sight passing within about 10″ of the nebular center, the C II column density is a factor 46 higher than the CO column density. The total mass of gas associated with the [C II] emission inside a circular region of diameter 87.″5 is at least 0.11 M$_\odot$. A significant amount of [C II] flux arises from a photodissociation region immediately outside the bright optical ring, where we find a C II to CO ratio of > 6.5, lower than that seen towards the central region. Comparing our data with lower-quality C I spectra, which indicate similarly large C I/CO ratios in NGC 6720, we conclude that the bulk of elemental carbon in NGC 6720 is divided roughly equally between C II and C I, and that the emissions from these species are far more robust tracers of circumstellar material than CO in this object and other evolved planetary nebulae.

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Conference Papers

A new extensive library of synthetic stellar spectra from PHOENIX atmospheres and its application to fitting VLT MUSE spectra

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We present a new library of synthetic spectra based on the stellar atmosphere code PHOENIX. It covers the wavelength range from 500 Å to 55 000 Å with a resolution of $R = 500\,000$ in the optical and near IR, $R = 100\,000$ in the IR and $\Delta\lambda = 0.1$ Å in the UV. The parameter space covers 2300 K $\leq T_{\rm eff} \leq$ 8000K, $0.0 \leq \log g \leq 6.0$, $-4.0 \leq$ [Fe/H] $\leq +1.0$ and $-0.3 \leq [\alpha/\mathrm{Fe}] \leq +0.8$. The library is work-in-progress and going to be extended to at least $T_{\rm eff} = 25\,000$ K. We use a new self-consistent way of describing the microturbulence for our model atmospheres. The entire library of synthetic spectra will be available for download. Futhermore we present a method for fitting spectra, especially designed to work with the new 2nd generation VLT instrument MUSE. We show that we can determine stellar parameters ($T_{\rm eff}$, log g, [Fe/H] and [α/Fe]) and even single element abundances.

Oral contribution, published in International Workshop on Stellar Spectral Libraries 2011
Available from arXiv:1203.1941

Direct constraints on the impact of TP-AGB stars on the SED of galaxies from near-infrared spectroscopy

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We present new spectro-photometric NIR observations of 16 post-starburst galaxies especially designed to test for the presence of strong carbon features of thermally pulsing AGB (TP-AGB) stars, as predicted by recent models of stellar population synthesis. Selection based on clear spectroscopic optical features indicating the strong predominance of stellar populations with ages between 0.5 and 1.5 Gyr and redshift around 0.2 allows us to probe the spectral region that is most affected by the carbon features of TP-AGB stars (unaccessible from the ground for $z \sim 0$ galaxies) in the evolutionary phase when their impact on the IR luminosity is maximum. Nevertheless, none of the observed galaxies display such features. Moreover the NIR fluxes relative to optical are consistent with those predicted by the original Bruzual & Charlot (2003) models, where the impact of TP-AGB stars is much lower than has been recently advocated.

Poster contribution, published in IAU Symposium No. 284, 2011, "The Spectral Energy Distribution of Galaxies", eds. R.J. Tuffs & C.C. Popescu
Available from arXiv:1203.4571

Announcements

Optical spectra of LX Cyg required

Me and colleagues in Vienna are currently studying the Mira variable LX Cyg. For our studies we would be very interested in an optical spectrum (any resolution) of that star, preferentially obtained before August 2011. The older the spectrum the better. Please contact me if you have such a spectrum and would be willing to share it with us.
Stefan Uttenthaler, Vienna
(stefan.uttenthaler@univie.ac.at)

The XII International Symposium on Nuclei in the Cosmos

Nuclei in the Cosmos XII (NICXII) will be held on the 5–10 August 2012 at the Cairns Convention Centre in Cairns, Australia. Nuclei in the Cosmos is the Premier international meeting in Nuclear Astrophysics. Researchers in nuclear physics, astronomy and astrophysics, meteoritics and planetary science, and cosmology get together to discuss current key multidisciplinary questions, such as the origin of the elements, the physics of thermonuclear stellar explosions, and the nature of dense nuclear matter. The NICXII school (http://www.mso.anu.edu.au/∼nicsch/NIC_School/Welcome .html) will be held the week before NICXII (30/7–3/8/2012) and hosted by the Australian National University in Canberra. The 75$^{\text{th}}$ Annual Meeting of the Meteoritical Society (http://shrimp.anu.edu.au/metsoc2012/) will be held in Cairns the week after NICXII (12–17 August 2012).

NICXII Event Key Dates

- November 2011: Registration & Abstracts Open
- 5$^{\text{th}}$ April 2012: Abstract Submission Closes
- 5$^{\text{th}}$ April 2012: Applications close for travel grants
- 14$^{\text{th}}$ May 2012: Submitters Notified of Abstract Presentations
- 5$^{\text{th}}$ June 2012: Late Registration Fee begins

See also http://www.nic2012.org/