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Editors: Jacco van Loon and Albert Zijlstra

Editorial

Dear Colleagues,

It is a pleasure to present you the 172nd issue of the AGB Newsletter. This time it's the images *Herschel* produces that feature prominently, as well as infrared colour classifications of objects, and catalogues of planetary nebulae and other post-AGB objects. New results on 47 Tucanae: is this the final word on red giant branch dust production? Certainly the final word has not yet been spoken on the nature of R Coronae Borealis. Novae and other symbiotic binaries are the subject of several papers, and other exotica include more planet detections around giant stars (perhaps no longer exotic but the norm?), Buckminsterfullerene, and the Murchison meteorite giving up some more of its secrets.

Please consider attending the meeting on late stages of stellar evolution, in Australia in December.

Unfortunately, there is also sad news to report. Perhaps not news to all of you, as it happened in January, but when the proceedings of the Vienna meeting of last year arrived in the post earlier this month, it was a shock to learn of the unfair passing away of Fredrik Schöier, so early in his life. He will be missed, and remembered.

The next issue is planned to be distributed around the 1st of December.

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

Newsletters are mainly to post in, not to read

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

Discovery of multiple dust shells beyond 1 arcmin in the circumstellar envelope of IRC +10 216 using *Herschel*/PACS

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We present new *Herschel*/PACS images at 70, 100, and 160 μm of the well-known, nearby, carbon-rich asymptotic giant branch star IRC +10 216 revealing multiple dust shells in its circumstellar envelope. For the first time, dust shells (or arcs) are detected until 320″. The almost spherical shells are non-concentric and have an angular extent between $\sim 40°$ and $\sim 200°$. The shells have a typical width of 5″–8″, and the shell separation varies in the range of $\sim 10''$–$35''$, corresponding to $\sim$ 500–1 700 yr. Local density variations within one arc are visible. The shell/intershell density contrast is typically ~ 4, and the arcs contain some 50% more dust mass than the smooth envelope. The observed (nested) arcs record the mass-loss history over the past 16 000 yr, but Rayleigh–Taylor and Kelvin–Helmholtz instabilities in the turbulent astropause and astrosheath will erase any signature of the mass-loss history for at least the first 200 000 yr of mass loss. Accounting for the bowshock structure, the envelope mass around IRC +10 216 contains > 2 $M_\odot$ of gas and dust mass. It is argued that the origin of the shells is related to non-isotropic mass-loss events and clumpy dust formation.

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Herschel/HIFI observations of molecular emission in protoplanetary nebulae and young planetary nebulae

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We aim to study the physical conditions, particularly the excitation state, of the intermediate-temperature gas in protoplanetary nebulae and young planetary nebulae (PPNe, PNe). The information that the observations of the different components deliver is of particular importance for understanding the evolution of these objects.
We performed *Herschel*/HIFI observations of intermediate-excitation molecular lines in the far-infrared/submillimeter range in a sample of ten nebulae. The high spectral resolution provided by HIFI allows the accurate measurement of the line profiles. The dynamics and evolution of these nebulae are known to result from the presence of several gas components, notably fast bipolar outflows and slow shells (that often are the fossil AGB shells), and the interaction between them. Because of the diverse kinematic properties of the different components, their emissions can be identified in the line profiles. The observation of these high-energy transitions allows an accurate study of the excitation conditions, particularly in the warm gas, which cannot be properly studied from the low-energy lines.
We have detected FIR/sub-mm lines of several molecules, in particular of ^{12}CO, ^{13}CO, and H_2O. Emission from other species, like NH_3, OH, $H_2{}^{18}O$, HCN, SiO, etc., has been also detected. Wide profiles showing sometimes spectacular line wings have been found. We have mainly studied the excitation properties of the high-velocity emission, which is known to come from fast bipolar outflows. From comparison with general theoretical predictions, we find that CRL 618 shows a particularly warm fast wind, with characteristic kinetic temperature $T_k \gtrsim 200$ K. In contrast, the fast winds in OH 231.8+4.2 and NGC 6302 are cold, $T_k \sim 30$ K. Other nebulae, like CRL 2688, show intermediate temperatures,

with characteristic values around 100 K. We also discuss how the complex structure of the nebulae can affect our estimates, considering two-component models. We argue that the differences in temperature in the different nebulae can be due to cooling after the gas acceleration (that is probably due to shocks); for instance, CRL 618 is a case of very recent acceleration, less than $\sim$ 100 yr ago, while the fast gas in OH 231.8+4.2 was accelerated $\sim$ 1000 yr ago. We also find indications that the densest gas tends to be cooler, which may be explained by the expected increase of the radiative cooling efficiency with the density.

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Resolved near-infrared stellar populations in nearby galaxies

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We present near-infrared (NIR) color–magnitude diagrams (CMDs) for the resolved stellar populations within 26 fields of 23 nearby galaxies (< 4 Mpc), based on F110W and F160W images from Wide Field Camera 3 (WFC3) on the *Hubble* Space Telescope (HST). The CMDs sample both old dormant and young star-forming populations. We match key NIR CMD features with their counterparts in optical CMDs, and identify the red core helium burning (RHeB) sequence as a significant contributor to the NIR flux in stellar populations younger than a few 100 Myrs old, suggesting that star formation can drive surprisingly rapid variations in the NIR mass-to-light ratio. The NIR luminosity of star forming galaxies is therefore not necessarily proportional to the stellar mass. We note that these individual bright RHeB stars may be misidentified as old stellar clusters in low resolution imaging. We also discuss the CMD location of asymptotic giant branch (AGB) stars, and the separation of AGB sub-populations using a combination of optical and NIR colors. We empirically calibrate the NIR magnitude of the tip of the red giant branch (TRGB) as a function of color, allowing this widely adopted filter to be used for distance measurements. We find a clear trend between NIR RGB color and metallicity. However, it appears unlikely that the slope of the NIR RGB can be used as a metallicity indicator in extragalactic systems with comparable data. Finally, we discuss scattered light in the WFC3, which becomes significant for exposures taken close to a bright earth limb.

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Circumstellar dust as a solution to the red supergiant supernova progenitor problem

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We investigate the red supergiant problem, the apparent dearth of Type IIP super-nova progenitors with masses between 16 and 30 $M_\odot$. Although red supergiants with masses in this range have been observed, none have been identified as progenitors in pre-explosion images. We show that, by failing to take into account the additional extinction resulting from the dust produced in the red supergiant winds, the luminosity of the most massive red supergiants at the end of their lives is underestimated. We re-estimate the initial masses of all Type IIP progenitors for which observations exist and analyse the resulting population. We find that the most likely maximum mass for a Type IIP progenitor is 21^{+2}_{-1} $M_\odot$. This is in closer agreement with the limit predicted from single star evolution models.

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Polarization properties of OH masers in AGB and post-AGB stars

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Context: Ground-state OH maser emission from late-type stars is usually polarized and remains a powerful probe of the magnetic field structure in the outer regions of circumstellar envelopes if observed with high angular and spectral resolutions. Observations in all four Stokes parameters are quite sparse and this is the most thorough, systematic study published to date.
Aims: We aim to determine polarization properties of OH masers in an extensive sample of stars that show copious mass loss and search for candidate objects that are well-suited for highangular resolution studies.
Methods: Full-polarization observations of the OH 1612 and 1667 MHz maser transitions were carried out for a sample of 117 AGB and post-AGB stars. Several targets were also observed in the 1665 MHz line.
Results: A complete set of full-polarization spectra is presented. Polarized features occur in more than 75% of the sources in the complete sample and there is no intrinsic difference in the occurrence of polarized emission between the three classes of objects of different infrared characteristics. The highest fractional polarization occurs for the post-AGB+PN and the Mira+SR classes at 1612 and 1667 MHz, respectively. Differences in the fractional polarization between the sources at different evolutionary stages appear to be related to depolarization caused by blending. The alignment of the polarization angles at the extreme sides of the shell implies a regular structure of the magnetic field of a strength of 0.3–2.3 mG.
Conclusions: Polarized OH maser features are widespread in AGB and post-AGB stars. The relationship between the circular and linear fractional polarizations for a representative sample are consistent with the standard models of polarization for the Zeeman splitting higher than the Doppler line width, whereas the polarized features are the σ components.

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Distance and kinematics of the red hypergiant VY CMa: VLBA and VLA astrometry

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We report astrometric results of phase-referencing VLBI observations of 43 GHz SiO maser emission toward the red hypergiant VY Canis Majoris (VY CMa) using the Very Long Baseline Array (VLBA). We measured a trigonometric parallax of 0.83 ± 0.08 mas, corresponding to a distance of $1.20^{+0.13}_{-0.10}$ kpc. Compared to previous studies, the spatial distribution of SiO masers has changed dramatically, while its total extent remains similar. The internal motions of the maser spots are up to 1.4 mas yr^{-1}, corresponding to 8 km s^{-1}, and show a tendency for expansion. After modeling the expansion of maser spots, we derived an absolute proper motion for the central star of $\mu_{\rm x} = -2.8 \pm 0.2$ and $\mu_{\rm y} = 2.6 \pm 0.2$ mas yr^{-1} eastward and northward, respectively. Based on the maser distribution from the VLBA observations, and the relative position between the radio photosphere and the SiO maser emission at 43 GHz from the complementary Very Large Array (VLA) observations, we estimate the absolute position of VY CMa at mean epoch 2006.53 to be $\alpha_{\rm J2000} = 07^{\rm h}22^{\rm m}58\overset{\rm s}{.}3259 \pm 0\overset{\rm s}{.}0007$, $\delta_{\rm J2000} = -25^\circ46'03\overset{''}{.}063 \pm 0\overset{''}{.}010$. The position and proper motion of VY CMa from the VLBA observations differ significantly with values measured by the *Hipparcos* satellite. These discrepancies are most likely associated with inhomogeneities and dust scattering the optical light in the circumstellar

envelope. The absolute proper motion measured with VLBA suggests that VY CMa may be drifting out of the giant molecular cloud to the east of it.

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Thermally pulsing Asymptotic Giant Branch star models and globular cluster Planetary Nebulae. I: The model

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Thermally pulsing asymptotic giant branch models of globular cluster stars are calculated using a synthetic model with the goal of reproducing the chemical composition, core masses and other observational parameters of the four known globular cluster planetary nebulae as well as roughly matching the overall cluster properties. The evolution of stars with an enhanced helium abundance (Y) and blue stragglers are modeled. New pre-thermally pulsing asymptotic giant branch mass-losses for red giant branch and early asymptotic giant branch stars are calculated from the *Padova* stellar evolution models (Bertelli et al. 2008, 2009). The new mass-losses are calculated to get the relative differences in mass-losses due to enhanced helium abundances.
The global properties of the globular cluster planetary nebula are reproduced with these models. The metallicity, mass of the central star, overall metallicities, helium abundance and the nebular mass are matched to the observational values. Globular cluster planetary nebulae JaFu 1 and JaFu 2 are reproduced by assuming progenitor stars with masses near the typical main sequence turn-offs of globular clusters and with enhanced helium abundances very similar to the enhancements inferred from fitting isochrones to globular cluster colour–magnitude diagrams. The globular cluster PN GJJC-1 can be roughly fit by a progenitor star with very extreme helium enhancement ($Y \approx 0.40$) near the turn-off producing a central star with the same mass as inferred by observations and a very low nebular mass. The abundances and core mass of planetary nebula Ps 1 and its central star (K 648) are reproduced by a blue straggler model. However, it turned out to be impossible to reproduce its nebular mass and it is concluded some kind of binary scenario may be needed to explain K 648.

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Substellar-mass companions to the K-Giants HD 240237, BD +48 738 and HD 96127

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We present the discovery of substellar-mass companions to three giant stars by the ongoing Penn State–Toruń Planet Search (PTPS) conducted with the 9.2 m *Hobby–Eberly* Telescope. The most massive of the three stars, K2 giant HD 240237, has a 5.3 M_J minimum mass companion orbiting the star at a 746-day period. The K0 giant BD +48 738 is orbited by a > 0.91 M_J planet which has a period of 393 days and shows a non-linear, long-term radial velocity trend that indicates a presence of another, more distant companion, which may have a substellar mass or be a low-mass star. The K2 giant HD 96127, has a > 4.0 M_J mass companion in a 647-day orbit around the star. The two K2 giants exhibit a significant RV noise that complicates the detection of low-amplitude, periodic variations in the data. If the noise component of the observed RV variations is due to solar-type oscillations, we show, using all the published data for the substellar companions to giants, that its amplitude is anti-correlated with stellar metallicity.

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Consequences of magnetic field structure for heat transport in magnetohydrodynamics

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Interfaces between hot and cold magnetized plasmas exist in various astrophysical contexts, for example where hot outflows impinge on an ambient interstellar medium (ISM). It is of interest to understand how the structure of the magnetic field spanning the interface affects the temporal evolution of the temperature gradient. Here we explore the relation between the magnetic field topology and the heat transfer rate by adding various fractions of tangled vs. ordered field across a hot-cold interface allow the system to evolve to a steady state. We find a simple mathematical relation for the rate of heat conduction as a function of the initial ratio of ordered to tangled field across the interface. We discuss potential implications for the astrophysical context of magnetized wind blown bubbles (WBB) around evolved stars.

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Available from arXiv:1110.0817

Probing substellar companions of Asymptotic Giant Branch stars through spirals and arcs

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Recent observations of strikingly well-defined spirals in the circumstellar envelopes of asymptotic giant branch (AGB) stars point to the existence of binary companions in these objects. In the case of planet or brown dwarf mass companions, we investigate the observational properties of the spiral-onion shell wakes due to the gravitational interaction of these companions with the outflowing circumstellar matter. Three-dimensional hydrodynamical simulations at high resolution show that the substellar mass objects produce detectable signatures, corresponding to density contrasts (10%–200%) and arm separations (10–400 AU) at 100 AU distance from the central star, for the wake induced by a Jupiter to brown dwarf mass object orbiting a solar mass AGB star. In particular, the arm pattern propagates in the radial direction with a speed depending on the *local* wind speed and sound speed, implying possible variations of the arm separation in the wind acceleration region and/or in a slow wind with significant temperature variation. The pattern propagation speeds of the inner and outer boundaries differ by twice the sound speed, leading to the overlap of high-density boundaries in slow winds and producing a subpattern of the spiral arm feature. Vertically, the wake forms concentric arcs with angular sizes anticorrelated to the wind Mach number. We provide an empirical formula for the peak density enhancement as a function of the mass, orbital distance, and velocity of the object as well as the wind and local sound speed. In typical condition of AGB envelopes, the arm–interarm density contrast can be greater than 30% of the background density within a distance of $\sim 10(M_{\rm p}/{\rm M_J})$ AU for the object mass $M_{\rm p}$ in units of Jupiter mass $\rm M_J$. These results suggest that such features may probe unseen substellar mass objects embedded in the winds of AGB stars and may be useful in planning future high-sensitivity/resolution observations with Atacama Large Millimeter/submillimeter Array.

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The VISIR@VLT mid-IR view of 47 Tuc: A further step in solving the puzzle of RGB mass loss

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There is an ongoing debate regarding the onset luminosity of dusty mass loss in population-II red giant stars. In this paper we present VISIR@VLT MIR 8.6 μm imaging of 47 Tuc, centre of attention of a number of space-based *Spitzer* observations and studies. The VISIR high resolution (diffraction limited) observations allow excellent matching to existing optical *Hubble* space telescope catalogues. The optical–MIR coverage of the inner 1.′15 of the cluster provide the cleanest possible, blending-free, sampling of the upper 3 magnitudes of the giant branch. Our diagrams show no evidence of faint giants with MIR-excess. A combined NIR–MIR diagram further confirms the near absence of dusty red giants. Dusty red giants and asymptotic giant stars are confined to the 47 Tuc long period variables population. In particular, dusty red giants are limited to the upper one 8.6 μm magnitude below the giant branch tip. This particular luminosity level corresponds to $\sim$ 1000 $L_{\odot}$, suggested in previous determinations to mark the onset of dusty mass-loss. Interestingly, at this luminosity level, we detect a small deviation between the colours of red giants and the theoretical isochrones.

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The VMC survey III. Mass-loss rates and luminosities of LMC AGB stars

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Dust radiative transfer models are presented for all 374 AGB stars candidates in one of the fields observed by the new VISTA survey of the Magellanic Clouds (VMC). Mass-loss rates, luminosities and a classification of C- and O-rich stars are derived by fitting the models to the spectral energy distribution obtained by combining VMC data with existing optical, near-, and mid-infrared photometry. This exploratory study shows that our method provides reliable mass-loss rates, luminosities and chemical classifications for all AGB stars. These results offer already important constraints to AGB evolutionary models. Most of our conclusions, especially for the rarer dust-enshrouded extreme AGB stars, are however strongly limited by the relatively small area covered by our study. Forthcoming VMC observations will easily remove this limitation. [abridged]

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A light-curve model of the symbiotic nova PU Vul (1979) – a very quiet explosion with long-lasted flat peak

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We present a light curve modelof the symbiotic nova PU Vul (Nova Vulpeculae 1979) that shows a long-lasted flat peak with no spectral indication of wind mass-loss before decline. Our quasi-evolution models consisting of a series of static solutions explain both the optical flat peak and ultraviolet (UV) light curve simultaneously. The white dwarf mass is estimated to be about 0.6 $M_\odot$. We also provide a new determination of the reddening, $E(B-V) = 0.43 \pm 0.05$ mag from UV spectral analysis. Theoretical light curve fitting of UV 1455 Å provides the distance of $d = 3.8 \pm 0.7$ kpc.

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Effects of a companion star on slow nova outbursts – transition from static to wind evolutions

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Two types of nova evolutions can be realized in low-mass white dwarfs of about 0.5–0.7 $M_\odot$, i.e. an evolution with optically thick winds like in usual classical novae, or an another type of evolution without them like in the symbiotic nova PU Vul. The latter type is characterized by spectra of no indication of strong winds as well as a long-lasted flat optical peak in its light curve. We propose a transition from no-optically thick wind evolution to usual evolution with optically thick winds as a new outburst model for slow novae that show a relatively long-lasted multipeak phase followed by a wind phase like in the slow novae V723 Cas, HR Del, and V5558 Sgr. We calculated nova envelopes with one-dimensional approximation of the companion's effects and found that when the companion star is deeply embedded in the extended nova envelope, the structure of static envelope Thus, the transition from static to wind solution is triggered by the effect of the companion. The transition occurs in a close binary nova like V723 Cas, but is not triggered in a long period binary like PU Vul. We reconfirm our previous results that the frictional energy deposition is negligibly small in almost all of hydrogen/helium novae because of the low envelope density at the orbit.

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Spectra probing the number ratio between C- and M-type AGB stars in the NGC 6822 galaxy

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NGC 6822 is a dwarf irregular galaxy with a large intermediate-age halo population containing carbon-rich (C-type) and oxygen-rich (M-type) asymptotic giant branch (AGB) stars. The C/M ratio is known to correlate with metallicity. Our aims are to calibrate spectroscopically the C vs. M-type Asymptotic Giant Branch (AGB) star selection made using

near-IR photometry, and to investigate the spatial distribution of C/M ratio in NGC 6822, based on low-resolution spectroscopy and near-IR photometry. We have obtained low-resolution multi-object spectroscopy with the VIMOS instrument at the ESO VLT for ~ 800 stars in seven fields centered on NGC 6822. The spectroscopic classification of giant stars in NGC 6822 and foreground dwarf contaminants has been made by comparison of more than 500 spectra with good quality with the spectroscopic atlas of Turnshek et al. (1985). The sample of spectroscopically confirmed AGB stars in NGC 6822 is split into C- and M-rich giants to constrain the C vs. M AGB star selection criteria based on photometry. The larger near-IR photometric sample is then used to investigate the C/M ratio gradients across the galaxy. We present the largest catalogue of near-IR photometry and spectra of AGB stars in NGC 6822 with 151 C stars and 123 M stars. 79% of the C-stars in our catalogue are redder than $(J-K)_0 = 1.2$ mag and 12% are brighter than $K_0 = 16.45$ mag and bluer than $(J-K)_0 = 1.2$ mag. The rest 9% are mixed with the M-type AGB stars. 88% of the latter have colours $(J-H)_0 > 0.73$ mag and $(J-K)_0$ between 0.9 mag and 1.2 mag. The rest are mixed with dwarfs and C-type stars. The foreground dwarfs have preferably colours $(J-H)_0 < 0.73$ mag (95%). Using the proposed criteria we estimate the overall C/M ratio of the galaxy to be around 0.8 with spread between $0.2 < C/M < 1.8$. These results suggest metallicity index [Fe/H] between -1.2 dex and -1.3 dex according to the different calibrations and with a significant spread of about $0.4 \div 0.6$ dex. Possible age rather than metallicity variations to explain the C/M ratio trends are also discussed.

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Tungsten isotopic compositions in stardust SiC grains from the Murchison meteorite: Constraints on the *s*-process in the Hf-Ta-W-Re-Os region

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We report the first tungsten isotopic measurements in stardust silicon carbide (SiC) grains recovered from the Murchison carbonaceous chondrite. The isotopes ^{182,183,184,186}W and ^{179,180}Hf were measured on both an aggregate (KJB fraction) and single stardust SiC grains (LS+LU fraction) believed to have condensed in the outflows of low-mass carbon-rich asymptotic giant branch (AGB) stars with close-to-solar metallicity. The SiC aggregate shows small deviations from terrestrial (=solar) composition in the ^{182}W/^{184}W and ^{183}W/^{184}W ratios, with deficits in ^{182}W and ^{183}W with respect to ^{184}W. The ^{186}W/^{184}W ratio, however, shows no apparent deviation from the solar value. Tungsten isotopic measurements in single mainstream stardust SiC grains revealed lower than solar ^{182}W/^{184}W, ^{183}W/^{184}W, and ^{186}W/^{184}W ratios. We have compared the SiC data with theoretical predictions of the evolution of W isotopic ratios in the envelopes of AGB stars. These ratios are affected by the slow neutron-capture process and match the SiC data regarding their ^{182}W/^{184}W, ^{183}W/^{184}W, and ^{179}Hf/^{180}Hf isotopic compositions, although a small adjustment in the *s*-process production of ^{183}W is needed in order to have a better agreement between the SiC data and model predictions. The models cannot explain the ^{186}W/^{184}W ratios observed in the SiC grains, even when the current ^{185}W neutron-capture cross section is increased by a factor of two. Further study is required to better assess how model uncertainties (e.g., the formation of the ^{13}C neutron source, the mass-loss law, the modelling of the third dredge-up, and the efficiency of the ^{22}Ne neutron source) may affect current *s*-process predictions.

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Distinguishing between H II regions and planetary nebulae with Hi-GAL, WISE, MIPSGAL, and GLIMPSE

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H II regions and planetary nebulae (PNe) both emit at radio and infrared (IR) wavelengths, and angularly small H II regions can be mistaken for PNe. This problem of classification is most severe for H II regions in an early evolutionary stage, those that are extremely distant, or those that are both young and distant. Previous work has shown that H II regions and PNe can be separated based on their infrared colors. Using data from the *Herschel* Hi-GAL survey, as well as WISE and the *Spitzer* MIPSGAL and GLIMPSE surveys, we wish to establish characteristic IR colors that can be used to distinguish between H II regions and PNe. We perform aperture photometry measurements for a sample of 126 H II regions and 43 PNe at wavelengths from 8.0 μm to 500 μm. We find that H II regions and PNe have distinct IR colors. The most robust discriminating color criteria are $[F_{12}/F_8] < 0.3$, $[F_{160}/F_{12}] > 1.3$, and $[F_{160}/F_{24}] > 0.8$ (or alternately $[F_{160}/F_{22}] > 0.8$), where the brackets indicate the log of the flux ratio. All three of these criteria are individually satisfied by over 98% of our sample of H II regions and by $\sim 10\%$ of our sample of PNe. Combinations of these colors are more robust in separating the two populations; for example all H II regions and no PNe satisfy $[F_{12}/F_8] < 0.4$ and $[F_{160}/F_{22}] > 0.8$. The dispersion in color is relatively small for H II regions; this suggests that any evolution in these colors with time for H II regions must be relatively modest. The spectral energy distributions (SEDs) of H II regions can be separated into "warm" and "cold" components. The "cold" component is well-fit by a grey-body of temperature 25 K. The SEDs of nearly two-thirds of our sample of H II regions peak at 160 μm and one third peak at 70 μm. For PNe, 67% of the SEDs peak at 70 μm, 23% peak at either 22 μm or 24 μm, and 9% (two sources) peak at 160 μm.

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The circumstellar environment of R Coronae Borealis: white dwarf merger or final helium shell flash?

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In 2007, R Coronae Borealis (R CrB) went into an historically deep and long decline. In this state, the dust acts like a natural coronagraph at visible wavelengths, allowing faint nebulosity around the star to be seen. Imaging has been obtained from 0.5 to 500 μm with *Gemini*/GMOS, HST/WFPC2, *Spitzer*/MIPS, and *Herschel*/SPIRE. Several of the structures around R CrB are cometary globules caused by wind from the star streaming past dense blobs. The estimated dust mass of the knots is consistent with their being responsible for the R CrB declines if they form along the line of sight to the star. In addition, there is a large diffuse shell extending up to 4 pc away from the star containing cool 25-K dust that is detected all the way out to 500 μm. The SED of R CrB can be well fit by a 150-AU disk surrounded by a very large diffuse envelope which corresponds to the size of the observed nebulosity. The total masses of the disk and envelope are 10^{-4} and 2 $M_\odot$, respectively, assuming a gas-to-dust ratio of 100. The evidence pointing toward a white-dwarf merger or a final-helium-shell flash origin for R CrB is contradictory. The shell and the cometary knots are consistent with a fossil planetary nebula. Along with the fact that R CrB shows significant lithium in its atmosphere, this supports the final-helium-shell flash. However, the relatively high inferred mass of R CrB and its high fluorine abundance support a white-dwarf merger.

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On the absorption of radiation by the negatively charged hydrogen

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The absorption of infrared and visible radiation from stellar emission spectra by the negatively charged hydrogen ions H^- is considered. We derive the explicit formulas which can be used to determine the total absorption coefficient (per unit volume) for the negatively charged hydrogen ions $^1H^-$ (protium) and $^2H^-$ (deuterium or D^-). The computed bound–free and free–free absorption coefficients a_ν and k_ν can be used to evaluate the actual absorption of infrared and visible radiation by the H^- ion in photospheres of many cold stars with surface temperatures $T_\star \leq 8,250$ K.

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Historical light curve and search for previous outbursts of Nova KT Eridani (2009)

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Context: Nova Eridani (2009) caught the eye of the nova community due to its fast decline from maximum, which was initially missed, and its subsequent development in the radio and X-ray wavelengths. This system also exhibits properties similar to those of the much smaller class of recurrent novae; themselves potential progenitors of Type Ia Supernovae.
Aims: We aim to determine the nature and physical parameters of the KT Eri progenitor system.
Methods: We searched the Harvard College Observatory archive plates for the progenitor of KT Eri to determine the nature of the system, particularly the evolutionary stage of the secondary. We used the data obtained to search for any periodic signal and the derived luminosity to estimate a recurrence timescale. Furthermore, by comparing the colours of the quiescent system on a colour–magnitude diagram we may infer the nature of the secondary star.
Results: We identified the progenitor system of KT Eri and measured a quiescent magnitude of $\langle B \rangle = 14.7 \pm 0.4$. No previous outburst was found. However, we suggest that if the nova is recurrent it should be on a timescale of centuries. We find a periodicity at quiescence of 737 days which may arise from reflection effects and/or eclipses in the central binary. The periodicity and the quiescence magnitude of the system suggest that the secondary star is evolved and likely in, or ascending, the Red Giant Branch. A second period is evident at 376 days which has a sinusoidal like light curve. Furthermore, the outburst amplitude of ~ 9 magnitudes is inconsistent with those expected for fast classical novae (~ 17 magnitudes) which may lend further support for an evolved secondary.
Conclusions: We investigated the probable recurrent nova KT Eri for which we suggest an inter-outburst period of order centuries and an evolved secondary. This may suggest that there is a whole range of possible inter-outburst periods in between the "typical" classical and recurrent novae nomenclature. Archival searches are an excellent tool in order to investigate the nature of astrophysical objects, in order to determine the nature and physical parameters.

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A far-infrared survey of bow shocks and detached shells around AGB stars and red supergiants

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Far-infrared *Herschel*/PACS images at 70 and 160 μm of a sample of 78 Galactic evolved stars are used to study the (dust) emission structures, originating from stellar wind–ISM interaction. In addition, two-fluid hydrodynamical simulations of the coupled gas and dust in wind–ISM interactions are used to compare with the observations. Four distinct classes of wind–ISM interaction (i.e. "fermata", "eyes", "irregular", and "rings") are identified and basic parameters affecting the morphology are discussed. We detect bow shocks for $\sim 40\%$ of the sample and detached rings for $\sim 20\%$. De-projected stand-off distances (R_0) – defined as the distance between the central star and the nearest point of the interaction region – of the detected bow shocks ("fermata" and "eyes") are derived from the PACS images and compared to previous results, model predictions and the simulations. All observed bow shocks have stand-off distances smaller than 1 pc. Observed and theoretical stand-off distances are used together to independently derive the local ISM density. Both theoretical (analytical) models and hydrodynamical simulations give stand-off distances for adopted stellar properties that are in good agreement with the measured de-projected stand-off distance of wind–ISM bow shocks. The possible detection of a bow shock – for the distance limited sample – appears to be governed by its physical size as set roughly by the stand-off distance. In particular the star's peculiar space velocity and the density of the ISM appear decisive in detecting emission from bow shocks or detached rings. Tentatively, the "eyes" class objects are associated to (visual) binaries, while the "rings" generally appear not to occur for M-type stars, only for C- or S-type objects that have experienced a thermal pulse.

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The San Pedro Mártir kinematic catalogue of Galactic Planetary Nebulae

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The San Pedro Mártir kinematic catalogue of galactic planetary nebulae provides spatially resolved, long-slit Échelle spectra for about 600 planetary nebulae. The data are presented wavelength calibrated and corrected for heliocentric motion. For most objects multiple spectra have been acquired and images with accurate slit positions on the nebulae are also presented for each object. This is the most extensive and homogeneous single source of data concerning the internal kinematics of the ionized nebular material in planetary nebulae. Data can be retrieved for individual objects or selected by groups that share some common characteristics, such as by morphological classes, galactic population, binary cores, presence of fast outflows, etc. The catalogue is available through the world wide web at http://kincatpn.astrosen.unam.mx

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Carbonaceous molecules in the oxygen-rich circumstellar environment of binary post-AGB stars: C_{60} fullerenes and polycyclic aromatic hydrocarbons

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Context: The circumstellar environment of evolved stars is generally rich in molecular gas and dust. Typically, the entire environment is either oxygen-rich or carbon-rich, depending on the evolution of the central star.
Aims: In this paper we discuss three evolved disc sources with evidence of atypical emission lines in their infrared spectra. The stars were taken from a larger sample of post-AGB binaries for which we have Spitzer infrared spectra, characterised by the presence of a stable oxygen-rich circumbinary disc. Our previous studies have shown that the infrared spectra of post-AGB disc sources are dominated by silicate dust emission, often with an extremely high crystallinity fraction. However, the three sources described here are selected because they show a peculiar molecular chemistry.
Methods: Using *Spitzer* infrared spectroscopy, we study in detail the peculiar mineralogy of the three sample stars. Using the observed emission features, we identify the different observed dust, molecular and gas species.
Results: The infrared spectra show emission features due to various oxygen-rich dust components, as well as CO_2 gas. All three sources show the strong infrared bands generally ascribed to polycyclic aromatic hydrocarbons. Furthermore, two sample sources show C_{60} fullerene bands.
Conclusions: Even though the majority of post-AGB disc sources are dominated by silicate dust in their circumstellar environment, we do find evidence that, for some sources at least, additional processing must occur to explain the presence of large carbonaceous molecules. There is evidence that some of these sources are still oxygen-rich, which makes the detection of these molecules even more surprising.

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The illumination and growth of CRL 2688: An analysis of new & archival HST observations

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We present four-color images of CRL 2688 obtained in 2009 using the Wide-Field Camera 3 on HST. The F606W image is compared with archival images in very similar filters to monitor the proper motions of nebular structure. We find that the bright N–S lobes have expanded uniformly by 2.5% and that the ensemble of rings has translated radially by $0\farcs07$ in 6.65 yr. The rings were ejected every 100 yr for $\sim$ 4 millennia until the lobes formed 250 yr ago. Starlight scattered from the edges of the dark E–W dust lane is coincident with extant H_2 images and leading tips of eight pairs of CO outflows. We interpret this as evidence that fingers lie within geometrically opposite cones of opening angles $\sim 30^\circ$ like those in CRL 618. By combining our results of the rings with ^{12}CO absorption from the extended AGB wind we ascertain that the rings were ejected at $\sim$ 18 km s^{-1} with very little variation and that the distance to CRL 2688, $v_{\rm exp}/\dot{\theta}_{\rm exp}$, is 300–350 pc. Our 2009 imaging program included filters that span 0.6 to 1.6 μm. We constructed a two-dimensional dust scattering model of stellar radiation through CRL 2688 that successfully

reproduces the details of the nebular geometry, its integrated spectral energy distribution, and nearly all of its color variations. The model implies that the optical opacity of the lobes $\gtrsim 1$, the dust particle density in the rings decreases as radius^{-3} and that the mass and momentum of the AGB winds and their rings have increased over time.

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Formation of a disk structure in the symbiotic binary AX Per during its 2007–10 precursor-type activity

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AX Per is an eclipsing symbiotic binary. During active phases, deep narrow minima are observed in its light curve, and the ionization structure in the binary changes significantly. From 2007.5, AX Per entered a new active phase. It was connected with a significant enhancement of the hot star wind. Simultaneously, we identified a variable optically thick warm ($T_{\rm eff} \sim 6000$ K) source that contributes markedly to the composite spectrum. The source was located at the hot star's equator and has the form of a flared disk, whose outer rim simulates the warm photosphere. The formation of the neutral disk-like zone around the accretor during the active phase was connected with its enhanced wind. We suggested that this connection represents a common origin of the warm pseudophotospheres that are indicated during the active phases of symbiotic stars.

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Tracking down R Coronae Borealis stars from their mid-infrared WISE colours

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R Coronae Borealis stars (RCBs) are hydrogen-deficient and carbon-rich supergiant stars. They are very rare, as only ~ 50 are actually known in our Galaxy. Interestingly, RCBs are strongly suspected to be the evolved merger product of two white dwarfs and could therefore be an important tool to understand Supernovae type Ia in the double degenerate scenario. Constraints on the spatial distribution and the formation rate of such stars are needed to picture their origin and test it in the context of actual population synthesis results. To do so, it is crucial to increase significantly the number of known RCBs. With an absolute magnitude $M_{\rm V} \sim -5$ and a bright/hot circumstellar shell made of amorphous carbon grains, RCBs are really distinctive stars. Mono-epoch mid-infrared data can help us to discriminate RCBs among other dust-producing stars. The aim is to produce from the WISE and 2MASS infrared catalogues a new catalogue of reasonable size, enriched with RCB stars. Colour–colour cuts used on all stars detected are the main selection criteria. The selection efficiency was monitored using the 52 known RCBs. It has been found that selection cuts in mid-infrared colour–colour diagrams are a very efficient method of discriminating RCBs from other stars. An RCB enriched catalogue made of only 1602 stars, with a high detection efficiency of about 77%, was produced. Spectral energy distributions of 49 known RCBs and 5 known HdCs are also presented with estimates of their photosphere and circumstellar shell temperatures. The newly released WISE all sky catalogue has proven to be a valuable resource in

finding RCB stars. Actual scenarios predict that between 100 and 500 RCBs exist in our Galaxy. The newly created RCB enriched catalogue is an important step forward to significantly increase the number of known RCB stars and therefore better understand their origin.

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VLBA SiO maser observations of the OH/IR star OH 44.8−2.3: magnetic field and morphology

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Context: SiO maser emission occurs in the extended atmosphere of evolved stars and can be studied at high angular resolution. As compact, high brightness components they can be used as important tracers of the dynamics at distances close to the central star. The masers also serve as probes of the evolutionary path from spherically symmetric AGB stars to aspherical PNe. Very long baseline interferometry (VLBI) observations of Mira variables indicate that SiO masers are significantly linearly polarized with linear polarization fraction up to 100%. However, no information is available at high angular resolution for SiO masers in higher mass loss OH/IR stars. Theory indicates a different SiO pumping mechanism in higher mass loss evolved stars.
Aims: We extend the VLBI SiO maser studies to OH/IR stars. The observations enable us to understand the SiO pumping mechanisms in higher mass loss evolved objects and compare those with Mira variables. Additionally, polarimetric observations of SiO masers help us to understand the magnetic field strength and morphology and to distinguish between conflicting polarization theories.
Methods: The 43 GHz SiO maser observations of the OH/IR star OH 44.8−2.3 were performed with the VLBA in full polarization spectral line mode. Auxiliary EVLA observations were performed to allow for the absolute calibration of the polarization angle. The Zeeman splitting was measured by cross correlating the right and left circular polarization spectra as well as the S-curve fitting. Additionally, we analyzed the 1612 MHz OH maser observations of OH 44.8−2.3 from the VLA archive.
Results: The SiO masers of OH 44.8−2.2 form a ring located at ~ 5.4 AU around the star. The masers appear to be highly linearly polarized with fractional linear polarization up to 100%. The linear polarization vectors are consistent with a dipole field morphology in this star. We report a tentative detection of circular polarization of $\sim 0.7\%$ for the brightest maser feature. The magnetic field measured for this feature corresponds to 1.5 ± 0.3 G. Additionally, the distribution of the 1612 MHz OH maser emission could indicate an elongated morphology.
Conclusions: The SiO masers in OH 44.8−2.3 exhibit a ring morphology. Even though the central AGB star of OH 44.8−2.3 is expected to be larger than typical Mira variables, the SiO masers occur at the similar distance from the stellar photosphere as Mira variables. The SiO masers and the 1612 MHz OH maser emission suggest a mildly preferred direction of the outflow in the CSE of this star. Significant linear polarization is measured for the SiO region of this star, which could originate from either collisional or radiative pumping. In any case, the observed polarization is also consistent with magnetic field structures along the preferred outflow direction. This could reflect the possible role of the magnetic field in shaping the circumstellar environment of this object. Although we cannot firmly distinguish between the different polarization theories, the derived magnetic field strength assuming standard Zeeman emission is fully consistent with other maser polarization measurements.

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Near- and mid-infrared colors of evolved stars in the Galactic Plane. The Q1 and Q2 parameters

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Mass loss from evolved stars chemically enriches the interstellar medium (ISM). Stellar winds from massive stars and their explosions as supernovae shape the ISM and trigger star formation. Studying evolved stars is fundamental for understanding galaxy formation and evolution at any redshift.
We aim to establish a photometric classification scheme for Galactic mass-losing evolved stars (e.g., WR, RSG, and AGB stars) with the goal of identifying new ones, and subsequently to use these samples as tracers of Galactic structure.
We searched for counterparts of known Galactic WR, LBV, RSG, and O-rich AGB stars in the 2MASS, GLIMPSE, and MSX catalogs, and we analyzed their properties with near- and mid-infrared color–color diagrams.
We used the Q1 parameter, which is a measure of the deviation from the interstellar reddening vector in the J–H versus H–K_s diagram, and we defined a new parameter, Q2, which is a measure of the deviation from the interstellar reddening vector in the J–K_s versus K_s–[8.0] diagram. The latter plane enables to distinguish between interstellar and circumstellar reddening, and to identify stars with circumstellar envelopes. WR stars and late-type mass-losing stars (AGBs and RSGs) are distributed in two different regions of the Q1 versus K_s–[8.0] diagram. A sequence of increasing [3.6]–[4.5] and [3.6]–[8.0] colors with increasing pulsation amplitudes (SRs, Miras, and OH/IR stars) is found. Spectra of Miras and OH/IR stars have stronger water absorption at 3.0 μm than SR stars or most of the RSGs. Masing Miras stars have water, but stronger SiO ($\sim$ 4 μm) and CO_2 absorption ($\sim$ 4.25 μm), as suggested by their [3.6]–[4.5] colors, bluer than those of non masing stars. A fraction of RSGs (22%) have the bluest [3.6]–[4.5] colors, but small Q2 values. We propose a new set of photometric criteria to distinguish among IR bright Galactic stars.
The GLIMPSE catalog is a powerful tool for photometric classification of Galactic mass-losing evolved stars. Our new criteria will yield many new RSGs and WRs.

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Conference Papers

Modeling the diffuse X-ray emission of Planetary Nebulae with different chemical composition

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Based on time-dependent radiation-hydrodynamics simulations of the evolution of Planetary Nebulae (PNe), we have carried out a systematic parameter study to address the non-trivial question of how the diffuse X-ray emission of PNe with closed central cavities is expected to depend on the evolutionary state of the nebula, the mass of the central star, and the metallicity of stellar wind and circumstellar matter. We have also investigated how the model predictions depend on the treatment of thermal conduction at the interface between the central 'hot bubble' and the 'cool' inner nebula, and compare the results with recent X-ray observations. Our study includes models whose properties resemble the extreme case of PNe with Wolf–Rayet type central stars. Indeed, such models are found to produce the highest X-ray luminosities.

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Wind accretion in symbiotic X-ray binaries

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The properties of wind accretion in symbiotic X-ray binaries (SyXBs) consisting of red-giant and magnetized neutron star (NS) are discussed. The spin-up/spin-down torques applied to NS are derived based on a hydrodynamic theory of quasi-spherical accretion onto magnetized NSs. In this model, a settling subsonic accretion proceeds through a hot shell formed around the NS magnetosphere. The accretion rate onto the NS is determined by the ability of the plasma to enter the magnetosphere. Due to large Reynolds numbers in the shell, the interaction of the rotating magnetosphere with plasma initiates a subsonic turbulence. The convective motions are capable of carrying the angular momentum through the shell. We carry out a population synthesis of SyXBs in the Galaxy with account for the spin evolution of magnetized NS. The Galactic number of SyXBs with bright ($M_V < 1$ mag) low-mass red-giant companion is found to be from ~ 40 to 120, and their birthrate is $\sim 5 \times 10^{-5}$–10^{-4} yr^{-1}. According to our model, among known SyXBs, Sct X-1 and IRXS 180431.1−273932 are wind-fed accretors. GX 1+4 lies in the transition from the wind-fed SyXBs to SyXBs in which the giants overflow their Roche lobe. The model successfully reproduces very long NS spins (such as in IGR J16358−4724 and 4U 1954+31) without the need to invoke very strong magnetic fields.

Oral contribution, published in 8th INTEGRAL Workshop, Dublin, PoS (INTEGRAL 2010)015
Available from arXiv:1110.1156
and from http://pos.sissa.it/archive/conferences/115/015/INTEGRAL

Ongoing surveys for close binary central stars and wider implications

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Binary central stars have long been invoked to explain the vexing shapes of planetary nebulae (PNe) despite there being scant direct evidence to support this hypothesis. Modern large-scale surveys and improved observing strategies have allowed us to significantly boost the number of known close binary central stars and estimate at least 20% of PNe have close binary nuclei that passed through a common-envelope (CE) phase. The larger sample of post-CE nebulae appears to have a high proportion of bipolar nebulae, low-ionisation structures (especially in SN 1987A-like rings) and polar outflows or jets. These trends are guiding our target selection in ongoing multi-epoch spectroscopic and photometric surveys for new binaries. Multiple new discoveries are being uncovered that further strengthen the connection between post-CE trends and close binaries. These ongoing surveys also have wider implications for understanding CE evolution, low-ionisation structure and jet formation, spectral classification of central stars, asymptotic giant branch (AGB) nucleosynthesis and dust obscuration events in PNe.

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Planetary Nebulae in the VISTA Magellanic Cloud (VMC) survey

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The multi-epoch YJK_s sub-arcsecond photometry of the VMC survey provides a long anticipated deep near-infrared (NIR) window into further understanding the stellar populations of the Magellanic Clouds. The first year of observations consisted of six tiles covering $\sim 9\%$ of the Large Magellanic Cloud (LMC) survey region and contains 102 objects previously classified as planetary nebulae (PNe). A large proportion of the sample were found to be contaminated by non-PNe. These initial results underline the importance of establishing a clean catalogue of LMC PNe before they are applied in areas such as the planetary nebula luminosity function (PNLF) and searches for binary central stars. As the VMC survey progresses it will play a fundamental role in cleaning extant PN catalogues and a complementary role in the discovery of new PNe.

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A consolidated online database of Galactic Planetary Nebulae

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Since the unifying Strasbourg–ESO Catalogue of Galactic Planetary Nebulae (SECGPN) a large number of new discoveries have been made thanks to improved surveys and discovery techniques. The increasingly heterogeneous published population of Galactic PNe, that we have determined totals < 2850 PNe, is becoming more difficult to study on the whole without a centralised repository. We introduce a consolidated and interactive online database with object classifications that reflect the latest multi-wavelength data and the most recent results. The extensible database, hosted by the Centre de Données astronomique de Strasbourg (CDS), will contain a wealth of observed data for large, well-defined samples of PNe including coordinates, multi-wavelength images, spectroscopy, line intensities, radial velocities and central star information. It is anticipated that the database will be publicly released early 2012.

Poster contribution, published in IAUS 283
Available from arXiv:1110.1832

Dust distribution in circumstellar shells

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We present numerical simulations of the hydrodynamical interactions that produce circumstellar shells. These simulations include several scenarios, such as wind–wind interaction and wind–ISM collisions. In our calculations we have

taken into account the presence of dust in the stellar wind. Our results show that, while small dust grains tend to be strongly coupled to the gas, large dust grains are only weakly coupled. As a result, the distribution of the large dust grains is not representative of the gas distribution. Combining these results with observations may give us a new way of validating hydrodynamical models of the circumstellar medium.

Poster contribution, published in "Planetary nebulae, an Eye to the Future", Tenerife, Spain, July 2011
Available from arXiv:1110.3144

Novae and accreting white dwarfs as progenitors of Type Ia supernovae

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I review various phenomena associated with mass-accreting white dwarfs (WDs) in relation to progenitors of type Ia supernovae (SNe Ia). The WD mass can be estimated from light curve analysis in multiwavelength bands based on the optically thick wind theory. In the single degenerate scenario of SNe Ia, two main channels are known, i.e. WD + main sequence (MS) channel and WD + red giant (RG) channel. In each channel, a typical binary undergoes three evolutional stages before explosion, i.e. the wind phase, supersoft X-ray source (SSS) phase, and recurrent nova phase in order of time because the accretion rate decreases with time as the companion mass decreases. We can specify some accreting WDs as the corresponding stage of evolution. Intermittent supersoft X-ray source like RX J0513.9−6951 and V Sge are corresponding to the wind phase objects. For the SSS phase Cal 87-type objects correspond to the WD + MS channel. For the WD + RG channel, soft X-ray observations of early-type galaxies gave a statistical evidence of SSS phase binaries. Recurrent novae of U Sco-type and RS Oph-type correspond to the WD + MS channel and WD + RG channel, respectively. Majority of recurrent novae host a very massive WD ($\gtrsim$1.35 $M_\odot$) and often show a plateau phase in optical light curve correspondingly to the long lasted supersoft X-ray phase: These properties are indications of increasing WD masses.

Oral contribution, published in "Binary Paths to the Explosions of Type Ia SNe", IAU Symposium 281 (2011)
Available from arXiv:1110.0055

Symbiotic stars as possible progenitors of SNe Ia: binary parameters and overall outlook

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Symbiotic stars are interacting binaries in which the first-formed white dwarf accretes and burns material from a red giant companion. This paper aims at presenting physical characteristics of these objects and discussing their possible link with progenitors of type Ia supernovae.

Oral contribution, published in "Binary Paths to Type Ia Supernovae", IAU Symposium No. 281, eds. R. Di Stefano & M. Orio, Cambridge University Press (Invited Review)
Available from arXiv:1110.1847

Symbiotic stars: Observations confront theory

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In this paper, I present and discuss some recent observational results which may have important implications for our understanding of late phases of binary evolution.

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Available from arXiv:1110.2361

The second release of the Toruń catalogue of Galactic post-AGB objects: Classification, morphology and spectra

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The investigation of post-AGB objects (proto-planetary nebulae) is very important from the standpoint of physical and chemical changes occurring during the late stages of stellar evolution. The *Toruń catalogue of Galactic post-AGB and related objects* is an evolutive catalogue containing astrometric, photometric and spectroscopic data as well as HST images for all known post-AGB objects and candidates in our Galaxy. This free-access catalogue can serve as an ideal tool to study different groups of post-AGB objects, especially due to the fact that all information is gathered in one place. The second release of our catalogue introduces a simple classification scheme of post-AGB objects and includes a significant number of new objects, photometric data, spectra and images. Here, using objects from the catalogue we consider the problem of the termination of the AGB phase.

Poster contribution, published in IAUS 283, "Planetary Nebulae: an Eye to the Future"
Available from arXiv:1110.3924

Herschel observations of PNe in the MESS key program

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In this paper we give a progress report on the *Herschel* imaging and spectroscopic observations of planetary nebulae that are carried out as part of the MESS guaranteed time key program. We present and discuss imaging and temperature

maps of NGC 6720, NGC 650, and NGC 6853, as well as PACS and SPIRE spectroscopy of NGC 7027.

Oral contribution, published in IAU Symposium 283, "Planetary Nebulae: An Eye to the Future"
Available from arXiv:1110.4524

Jet power in pre-Planetary Nebulae: Observations vs. theory

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High velocity jets are among the most prominent features of a wide class of planetary nebulae, but their origins are not understood. Several different types of physical model have been suggested to power the jets, but there is no consensus or preferred scenario. We compare current theoretical ideas on jet formation with observations, using the best studied pre-planetary nebulae in millimeter CO, where the dynamical properties are best defined. In addition to the mass, velocity, momentum, and energy of the jets, the mass and energetics of the equatorial mass-loss that typically accompanies jet formation prove to be important diagnostics. Our integrated approach provides estimates for some key physical quantities – such as the binding energy of the envelope when the jets are launched – and allows testing of model features using correlations between parameters. Even with a relatively small sample of well-observed objects, we find that some specific scenarios for powering jets can be ruled out or rendered implausible, and others are promising at a quantitative level.

Oral contribution, published in "Planetary Nebulae: an Eye to the Future", IAU Symposium 283, eds. A. Manchado, L. Stanghellini & D. Schönberner
Available from arXiv:1110.4396

Elemental abundances in AGB stars and the formation of the Galactic Bulge

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We obtained high-resolution near-IR spectra of 45 AGB stars located in the Galactic Bulge. The aim of the project is to determine key elemental abundances in these stars to help constrain the formation history of the bulge. A further aim is to link the photospheric abundances to the dust species found in the winds of the stars. Here we present a progress report of the analysis of the spectra.

Poster contribution, published in "Assembling the Puzzle of the Milky Way", Le Grand-Bornand, France, 17–22 April 2011, European Physical Journal, eds. C. Reylé, A. Robin and M. Schultheis
Available from arXiv:1110.4202

Estimating the binary fraction of planetary nebula central stars

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During the past 20 years, the idea that non-spherical planetary nebulae (PN) may need a binary or planetary interaction to be shaped was discussed by various authors. It is now gener- ally agreed that the varied morphologies of PN cannot be fully explained solely by single star evolution. Observationally, more binary central stars of planetary nebulae (CSPN) have been discovered, opening new possibilities to understand the connections between binarity and morphology. So far, $\simeq$ 45 binary CSPN have been detected, most being close systems detected via flux variability. To determine the PN binary fraction, one needs a method to detect wider binaries. We present here recent results obtained with the various techniques described, concentrating on binary infrared excess observations aimed at detecting binaries of any separation.

Poster contribution, published in IAUS 283: "Planetary Nebulae, an Eye to the Future"
Available from arXiv:1110.4192

Searching for binary central stars of planetary nebulae with *Kepler*

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The *Kepler* Observatory offers unprecedented photometric precision ($<$ 1 mmag) and cadence for monitoring the central stars of planetary nebulae, allowing the detection of tiny periodic light curve variations, a possible signature of binarity. With this precision free from the observational gaps dictated by weather and lunar cycles, we are able to detect companions at much larger separations and with much smaller radii than ever before. We have been awarded observing time to obtain lightcurves of the central stars of the six confirmed and possible planetary nebulae in the *Kepler* field, including the newly discovered object Kn 61, at cadences of both 30 min and 1 min. Of these six objects, we could confirm for three a periodic variability consistent with binarity. Two others are variables, but the initial data set presents only weak periodicities. For the central star of Kn 61, *Kepler* data will be available in the near future.

Poster contribution, published in IAUS 283: "Planetary Nebulae, an Eye to the Future"
Available from arXiv:1110.4436

Review Papers

Extragalactic Planetary Nebulae: tracers of the chemical evolution of nearby galaxies

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The study of the chemical composition of Planetary Nebulae in external galaxies is of paramount importance for the fields of stellar evolution and chemical enrichment history of galaxies. In the last years a number of spectroscopic studies with 6–8m-class telescopes have been devoted to this subject improving our knowledge of, among other, the time-evolution of the radial metallicity gradient in disk galaxies, the chemical evolution of dwarf galaxies, and the stellar evolution at low metallicity.

Published in IAU Symposium 283, "Planetary Nebulae: an Eye to the Future", Tenerife, 25–29 July 2011 (Invited Review)
Available from arXiv:1110.1186

Optical properties and applications of silicon carbide in astrophysics

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This book chapter, primarily written for materials scientists, reviews the role of SiC dust grains in astrophysical environments (where it is found versus where it is absent) and the current state-of-the-art in meteoritic, ultraviolet to infrared spectroscopic, and optical function astrophysics literature on SiC. Section 3 of this chapter also includes previously unpublished laboratory data on SiC (e.g., optical functions for 4H SiC, 21 μm feature) to fill in certain gaps in the astrophysics literature.

Published in "Silicon Carbide – Materials, Processing and Applications in Electronic Devices", ed. Moumita Mukherjee, ISBN: 978-953-307-968-4, InTech
Available from http://www.intechopen.com/articles/show/title/optical-properties-and-applications-of-silicon-carbide-in-astrophysics

Announcement

Late Phases of Stellar Evolution
Workshop of the Macquarie University Research Centre for Astronomy, Astrophysics and Astrophotonics

Phases of Late Stage Stellar Evolution
5–7 Dec 2011, Sydney, Australia

Major topics: RGB & AGB stars, Post-AGB stars, Planetary Nebulae & their Central Stars, White Dwarfs, Supernovae & their Remnants, Pulsars.

Rationale: The idea is to bring together experts and researchers across these related areas of late stage stellar evolution and to explore their transitions and demarcations from one to another as a function of age, mass, metallicity and environment.

Invited speakers include: Martin Asplund, Martin Cohen, Phil Diamond, Paul Dobbie, Bryan Gaensler, Martin Guerrero, Michael Ireland, John Lattanzio, Orsola De Marco, Jeremy Mould, Lister Staveley-Smith, Dennis Stello, Peter Wood, Albert Zijlstra, and Stuart Ryder.

Registration is limited to 60 so it is recommended to register as soon as possible.

See also http://www.physics.mq.edu.au/astronomy/MQAAAstro-workshop/