THE AGB NEWSLETTER

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

Official publication of the IAU Working Group on Abundances in Red Giants

No. 163 — 1 February 2011

http://www.astro.keele.ac.uk/AGBnews

Editors: Jacco van Loon and Albert Zijlstra

Editorial

Dear Colleagues,

It is our pleasure to present you the 163$^{\rm rd}$ issue of the AGB Newsletter.

Great news on the job market: postdoctoral fellowship are offered in beautiful Granada (one of which is tenure-track) and equally-beautiful Padova, and a PhD studentship is available in (no doubt also beautiful) Denver.

The next issue is planned to be distributed on the 1$^{\rm st}$ of March 2011.

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

suggestions, anyone?

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

An interferometric spectral-line survey of IRC +10 216 in the 345 GHz band

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We report a spectral-line survey of the extreme carbon star IRC +10 216 carried out between 293.9 and 354.8 GHz with the Submillimeter Array. A total of 442 lines were detected, more than 200 for the first time; 149 are unassigned. Maps at an angular resolution of $\sim 3''$ were obtained for each line. A substantial new population of narrow lines with an expansion velocity of ~ 4 km s^{-1} (i.e. $\approx 30\%$ of the terminal velocity) was detected. Most of these are attributed to rotational transitions within vibrationally excited states, emitted from energy levels above the $v = 0, J = 0$ ground state with excitation energy of 1000–3000 K. Emission from these lines appears to be centered on the star with an angular extent of $< 1''$. We use multiple transitions detected in several molecules to derive physical conditions in this inner envelope of IRC +10 216.

Accepted for publication in Astrophysical Journal Supplement Series
Available from arXiv:1012.5665

Fluorine and sodium in C-rich low-metallicity stars

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We present the N, O, F and Na abundance and ^{12}C/^{13}C isotopic ratio measurements or upper limits for a sample of 10 C-rich, metal-poor giant stars, eight enhanced in s-process (CEMP-s) elements and two poor in n-capture elements (CEMP-no). The abundances are derived from IR, K-band, high-resolution CRIRES@VLT spectra obtained. The metallicity of our sample ranges from [Fe/H] = −3.4 to −1.3. F abundance could be measured only in two CEMP-s stars. With [F/Fe] = 0.64, one is mildly F-overabundant, while the other is F-rich, at [F/Fe] = 1.44. For the remaining eight objects, including both CEMP-no in our sample, only upper limits on F abundance could be placed. Our measurements and upper limits show that there is a spread in [F/C+N] ratio in CEMP-s stars as predicted by theory. Predictions from nucleosynthetic models for low-mass, low-metallicity Asymptotic Giant Branch stars, account for the derived F abundances, while the upper limits on F content derived for most of the stars are lower than the predicted values. The measured Na content is accounted for by AGB models in the 1.25 to 1.7 $M_\odot$ range, confirming that the stars responsible for the peculiar abundance pattern observed in CEMP-s stars are low-mass, low-metallicity AGB stars, in agreement with the most accepted astrophysical scenario. We conclude that the mechanism of F production in current state-of-the-art low-metallicity low-mass AGB models needs further scrutiny and that F measurements in a larger number of metal-poor stars are needed to better constraint the models.

Accepted for publication in ApJ
Available from arXiv:1012.2800

Young planetary nebulae: *Hubble* Space Telescope imaging and a new morphological classification system

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Using *Hubble* Space Telescope images of 119 young planetary nebulae, most of which have not previously been published, we have devised a comprehensive morphological classification system for these objects. This system generalizes a recently devised system for pre-planetary nebulae, which are the immediate progenitors of planetary nebulae (PNs). Unlike previous classification studies, we have focussed primarily on young PNs rather than all PNs, because the former best show the influences or symmetries imposed on them by the dominant physical processes operating at the first and primary stage of the shaping process. Older PNs develop instabilities, interact with the ambient interstellar medium, and are subject to the passage of photoionization fronts, all of which obscure the underlying symmetries and geometries imposed early on. Our classification system is designed to suffer minimal prejudice regarding the underlying physical causes of the different shapes and structures seen in our PN sample, however, in many cases, physical causes are readily suggested by the geometry, along with the kinematics that have been measured in some systems. Secondary characteristics in our system such as ansae indicate the impact of a jet upon a slower-moving, prior wind; a waist is the signature of a strong equatorial concentration of matter, whether it be outflowing or in a bound Keplerian disk, and point symmetry indicates a secular trend, presumably precession, in the orientation of the central driver of a rapid, collimated outflow.

Accepted for publication in Astronomical Journal
Available from arXiv:1101.2214
and from ftp://ftp.astro.ucla.edu/pub/morris/AJ-360163-sahai.pdf

IRAS 17423−1755 (Hen 3-1475) revisited: an O-rich high-mass post-Asymptotic Giant Branch Star

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The high-resolution ($R = 600$) *Spitzer*/IRS spectrum of the bipolar proto planetary nebula (PN) IRAS 17423−1755 is presented in order to clarify the dominant chemistry (C-rich versus O-rich) of its circumstellar envelope as well as to constrain its evolutionary stage. The high quality *Spitzer*/IRS spectrum shows weak 9.7 μm absorption from amorphous silicates. This confirms for the first time the O-rich nature of IRAS 17423−1755 in contradiction to a previous C-rich classification, which was based on the wrong identification of the strong 3.1 μm absorption feature seen in the Infrared Space Observatory (ISO) spectrum as due to acetylene (C_2H_2). The high-resolution *Spitzer*/IRS spectrum displays a complete lack of C-rich mid-IR features such as molecular absorption features (e.g., 13.7 μm C_2H_2, 14.0 μm HCN, etc.) or the classical polycyclic aromatic hydrocarbon infrared emission bands. Thus, the strong 3.1 μm absorption band toward IRAS 17423−1755 has to be identified as water ice. In addition, an [Ne II] nebular emission line at 12.8 μm is clearly detected, indicating that the ionization of its central region may be already started. The spectral energy distribution in the infrared (2–200 μm) and other observational properties of IRAS 17423−1755 are discussed in comparison with the similar post-asymptotic giant branch (AGB) objects IRAS 19343+2926 and IRAS 17393−2727. We conclude that IRAS 17423−1755 is an O-rich high-mass post-AGB object that represents a link between OH/IR stars with extreme outflows and highly bipolar PN.

Accepted for publication in The Astronomical Journal
Available from arXiv:1101.1762
and from http://www.iac.es/folleto/research/preprints/?c=view&pre_id=11001

H_2 infrared line emission from the ionized region of planetary nebulae

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The analysis and interpretation of the H_2 line emission from planetary nebulae have been done in the literature assuming that the molecule survives only in regions where the hydrogen is neutral, as in photodissociation, neutral clumps or shocked regions. However, there is strong observational and theoretical evidence that at least part of the H_2 emission is produced inside the ionized region of such objects. The aim of the present work is to calculate and analyze the infrared line emission of H_2 produced inside the ionized region of planetary nebulae using a one-dimensional photoionization code. The photoionization code Aangaba was improved in order to calculate the statistical population of the H_2 energy levels, as well as the intensity of the H_2 infrared emission lines in physical conditions typical of planetary nebulae. A grid of models was obtained and the results are analyzed and compared with the observational data. We show that the contribution of the ionized region to the H_2 line emission can be important, particularly in the case of nebulae with high temperature central stars. This result explains why H_2 emission is more frequently observed in bipolar planetary nebulae (Gatley's rule), since this kind of object typically has hotter stars. Collisional excitation plays an important role on the population of the rovibrational levels of the electronic ground state of H_2 molecules. Radiative mechanisms are also important, particularly for the upper vibrational levels. Formation pumping can have minor effects on the line intensities produced by de-excitation from very high rotational levels, especially in dense and dusty environments. We included the effect of the H_2 molecule on the thermal equilibrium of the gas, concluding that, in the ionized region, H_2 only contributes to the thermal equilibrium in the case of a very high temperature of the central star or a high dust-to-gas ratio, mainly through collisional de-excitation.

Accepted for publication in Astronomy & Astrophysics
Available from arXiv:1012.4477

Possible signs of water and differentiation in a rocky exoplanetary body

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Spitzer observations reveal the presence of warm debris from a tidally destroyed rocky and possibly icy planetary body orbiting the white dwarf GD 61. Ultraviolet and optical spectroscopy of the metal-contaminated stellar photosphere reveal traces of hydrogen, oxygen, magnesium, silicon, iron, and calcium. The nominal ratios of these elements indicate an excess of oxygen relative to that expected from rock-forming metal oxides, and thus it is possible that water was accreted together with the terrestrial-like debris. Iron is found to be deficient relative to magnesium and silicon, suggesting the material may have originated as the outer layers of a differentiated parent body, as is widely accepted for the Moon.

Accepted for publication in ApJ Letters
Available from arXiv:1101.0158

The magnetic and metallic degenerate G 77-50

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An accumulation of multi-epoch, high-resolution, optical spectra reveal that the nearby star G 77-50 is a very cool DAZ white dwarf externally polluted by Mg, Fe, Al, Ca, and possibly Na, Cr, Mn. The metallic and hydrogen absorption features all exhibit multiple components consistent with Zeeman splitting in a $B \sim 120$ kG magnetic field. Ultraviolet through infrared photometry combined with trigonometric parallaxes yield $T_{\rm eff} = 5310$ K, $M = 0.60$ M$_\odot$, and a cooling age of 5.2 Gyr. The space velocity of the white dwarf suggests possible membership in the Galactic thick disk, consistent with an estimated total age of 8.6 Gyr. G 77-50 is spectrally similar to G 165-7 and LHS 2534; these three cool white dwarfs comprise a small group exhibiting both metals and magnetism. The photospheric metals indicate accretion of rocky debris similar to that contained in asteroids, but the cooling age implies a remnant planetary system should be stable. A possibility for G 77-50 and similarly old, polluted white dwarfs is a recent stellar encounter that dynamically rejuvenated the system from the outside-in. Metal abundance measurements for these cooler white dwarfs have the potential to distinguish material originating in outer region planetesimals injected via fly-by. If common envelope evolution can generate magnetic fields in white dwarfs, then G 77-50 and its classmates may have cannibalized an inner giant planet during prior evolution, with their metals originating in terrestrial bodies formed further out. Although speculative, this scenario can be ruled out if terrestrial planet formation is prohibited in systems where a giant planet has migrated to the inner region nominally engulfed during the post-main sequence.

Accepted for publication in MNRAS
Available from arXiv:1101.2203

Infrared emission from the composite grains: Effects of inclusions and porosities on the 10 and 18 μm features

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In this paper we study the effects of inclusions and porosities on the emission properties of silicate grains and compare the model curves with the observed infrared emission from circumstellar dust.

We calculate the absorption efficiency of the composite grain, made up of a host silicate oblate spheroid and inclusions of ice/graphite/or voids, in the spectral region 5.0–25.0 μm. The absorption efficiencies of the composite spheroidal oblate grains for three axial ratios are computed using the discrete dipole approximation (DDA). We study the absorption as a function of the volume fraction of the inclusions and porosity. In particular, we study the variation in the 10 μm and 18 μm emission features with the volume fraction of the inclusions and porosities. We then calculate the infrared fluxes for these composite grains at several dust temperatures ($T = 200$–350 K) and compare the model curves with the average observed IRAS-LRS curve, obtained for circumstellar dust shells around oxygen rich M-type stars. The model curves are also compared with two other individual stars.

The results on the composite grains show variation in the absorption efficiencies with the variation in the inclusions and porosities. In particular, it is found that the wavelength of peak absorption at 10 μm, shifts towards longer wavelengths with variation in the volume fraction of the inclusions of graphite. The spheroidal composite grains with axial ratio ~ 1.33; volume fraction of $f = 0.1$ and dust temperature between 210–340 K, fit the observed infra-red emission from circumstellar dust reasonably well in the wavelength range 5–25 μm. The model flux ratio, $R = F(18\ \mu\text{m})/F(10\ \mu\text{m})$, compares well with the observed ratio for the circumstellar dust.

The results on the composite grains clearly indicate that the silicate feature at 10 μm shifts with the volume fraction of graphite inclusions. The feature does not shift with the porosity. Both the features do not show any broadening with the inclusions or porosity. The absorption efficiencies of the composite grains calculated using DDA and Effective

Medium Approximation (EMA) do not agree. The composite grain models presented in this study need to be compared with the observed IR emission from the circumstellar dust around a few more stars.

Accepted for publication in Astronomy & Astrophysics
Available from arXiv:1101.1782

Are C60 molecules detectable in circumstellar shells of R Coronae Borealis stars?

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The hydrogen-poor, helium-rich and carbon-rich character of the gas around R Coronae Borealis (RCB) stars has been suggested to be a site for formation of C60 molecules. This suggestion is not supported by observations reported here showing that infrared transitions of C60 are not seen in a large sample of RCB stars observed with the Infrared Spectrograph on the *Spitzer* Space Telescope. The infrared C60 transitions are seen, however, in emission and blended with PAH-features in spectra of DY Cen and possibly also of V854 Cen, the two least hydrogen-deficient (hydrogen deficiency of only $\sim$ 10–100) RCB stars. The speculation is offered that C60 (and the PAHs) in the moderately H-deficient circumstellar envelopes may be formed by the decomposition of hydrogenated amorphous carbon but fullerene formation is inefficient in the highly H-deficient environments of most RCBs.

Accepted for publication in The Astrophysical Journal
Available from arXiv:1101.2253
and from http://www.iac.es/folleto/research/preprints/?c=view&pre_id=11004

Measurement of the distance and proper motions of the H_2O masers in the young Planetary Nebula K 3-35

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In this paper we present the results of very long baseline interferometry (VLBI) observations carried out with the VLBI Exploration of Radio Astrometry (VERA) array and the Very Long Baseline Array (VLBA) toward H2O masers in the young planetary nebula K 3-35. From the VERA observations we measured the annual parallax and proper motion of a bright water maser spot in K 3-35. The resulting distance is $D = 3.9^{+0.7}_{-0.5}$ kpc. This is the first time that the parallax of a planetary nebula is obtained by observations of its maser emission. On the other hand, the proper motion of K 3-35 as a whole was estimated to be $\mu_\alpha = -3.34 \pm 0.10$ mas yr^{-1}, $\mu_\delta = -5.93 \pm 0.07$ mas yr^{-1}. From these

results we determined the position and velocity of K 3-35 in Galactic cylindrical coordinates: $(R, \theta, z) = (7.11^{+0.08}_{-0.06}$ kpc, $27 \pm 5^{\circ}$, 140^{+25}_{-18} pc) and $(V_{\rm R}, V_{\theta}, V_{\rm z}) = (33 \pm 16, 233 \pm 11, 11 \pm 2)$ km s^{-1}, respectively. Additionally, from our VLBA observations we measured the relative proper motions among the water maser spots located in the central region of the nebula, which have been proposed to be tracing a toroidal structure. The distribution and relative proper motions of the masers, compared with previous reported observed epochs, suggest that such structure could be totally destroyed within a few years, due to the action of high velocity winds and the expansion of the ionization front in the nebula.

Accepted for publication in PASJ
Available from arXiv:1101.1160

Near-infrared absorption properties of oxygen-rich stardust analogues: The influence of coloring metal ions

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Context: Several astrophysically relevant solid oxides and silicates have extremely small opacities in the visual and near-infrared in their pure forms. Datasets for the opacities and for the imaginary part k of their complex indices of refraction are hardly available in these wavelength ranges.
Aims: We aimed at determining k for spinel, rutile, anatase, and olivine, especially in the near-infrared region. Our measurements were made with impurity-containing, natural, and synthetic stardust analogs.
Methods: Two experimental methods were used: preparing small sections of natural minerals and synthesizing melt droplets under the electric arc furnace. In both cases, the aborption properties of the samples were measured by transmission spectroscopy.
Results: For spinel ($MgAl_2O_4$), anatase, rutile (both TiO_2), and olivine ($(Mg,Fe)_2SiO_4$), the optical constants have been extended to the visual and near-infrared. We highlight that the individual values of $k(\lambda)$ and the absorption cross section $Q_{\rm abs}(\lambda)$ depend strongly on the content in transition metals like iron. Based on our measurements, we infer that k values below 10^{-5} are very rare in natural minerals including stardust grains, if they occur at all.
Conclusions: Data for k and $Q_{\rm abs}(\lambda)$ are important for various physical properties of stardust grains such as temperature and radiation pressure. With increasing $Q_{\rm abs}(\lambda)$ due to impurities, the equilibrium temperature of small grains in circumstellar shells increases as well. We discuss why and to what extent this is the case.

Accepted for publication in Astronomy and Astrophysics
Available from arXiv:1101.0695

Planetary nebulae in the inner Milky Way II: the Bulge–Disk transition

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In this work, a sample of planetary nebulae located in the inner-disk and bulge of the Galaxy is used in order to find the galactocentric distance which better separates these two populations, from the point of view of abundances. Statistical distance scales were used to study the distribution of abundances across the disk–bulge interface. A Kolmogorov–Smirnov test was used to find the distance in which the chemical properties of these regions better separate.
The results of the statistical analysis indicate that, on the average, the inner population has lower abundances than the outer. Additionally, for the α-elements abundances, the inner population does not follow the disk radial gradient towards the galactic center. Based on our results, we suggest a bulge–disk interface at 1.5 kpc, marking the transition between the bulge and inner-disk of the Galaxy, as defined by the intermediate mass population.

Accepted for publication in RMxAA
Available from arXiv:1101.3304

Fundamental parameters, integrated RGB mass loss and dust production in the Galactic globular cluster 47 Tucanae

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Fundamental parameters and time-evolution of mass loss are investigated for post-main-sequence stars in the Galactic globular cluster 47 Tucanae (NGC 104). This is accomplished by fitting spectral energy distributions (SEDs) to existing optical and infrared photometry and spectroscopy, to produce a true Hertzsprung–Russell diagram. We confirm the cluster's distance as $d = 4611^{+213}_{-200}$ pc and age as 12 ± 1 Gyr. Horizontal branch models appear to confirm that no more RGB mass loss occurs in 47 Tuc than in the more-metal-poor ω Centauri, though difficulties arise due to inconsistencies between the models. Using our SEDs, we identify those stars which exhibit infrared excess, finding excess only among the brightest giants: dusty mass loss begins at a luminosity of $\sim$ 1000 $L_\odot$, becoming ubiquitous above $L = 2000$ $L_\odot$. Recent claims of dust production around lower-luminosity giants cannot be reproduced, despite using the same archival *Spitzer* imagery.

Accepted for publication in Astrophysical Journal Supplements
Available from arXiv:1101.1095

Dust production and mass loss in the Galactic globular cluster 47 Tucanae

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Dust production among post-main-sequence stars is investigated in the Galactic globular cluster 47 Tucanae (NGC 104) based on infrared photometry and spectroscopy. We identify metallic iron grains as the probable dominant opacity source in these winds. Typical evolutionary timescales of AGB stars suggest the mass-loss rates we report are too high. We suggest that this is because the iron grains are small or elongated and/or that iron condenses more efficiently than at solar metallicity. Comparison to other works suggests metallic iron is observed to be more prevalent towards lower metallicities. The reasons for this are explored, but remain unclear. Meanwhile, the luminosity at which dusty mass loss begins is largely invariant with metallicity, but its presence correlates strongly with long-period variability. This suggests that the winds of low-mass stars have a significant driver that is not radiation pressure, but may be acoustic driving by pulsations.

Accepted for publication in Astrophysical Journal
Available from arXiv:1101.1096

Far-infrared imaging of post-AGB stars and (proto)-planetary nebulae with the AKARI Far-Infrared Surveyor

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By tracing the distribution of cool dust in the extended envelopes of post-AGB stars and (proto)-planetary nebulae ((P)PNe) we aim to recover, or constrain, the mass loss history experienced by these stars in their recent past. The Far-Infrared Surveyor (FIS) instrument on board the AKARI satellite was used to obtain far-infrared maps for a selected sample of post-AGB stars and (P)PNe. We derived flux densities (aperture photometry) for 13 post-AGB stars and (P)PNe at four far-infrared wavelengths (60, 90, 140, and 160 μm). Radial (azimuthally averaged) profiles are used to investigate the presence of extended emission from cool dust. No (detached) extended emission is detected for any target in our sample at levels significant with respect to background and cirrus emission. Only IRAS 21046+4739 reveals tentative excess emission between 30 and 130$''$. Estimates of the total dust and gas mass from the obtained maps indicate that the envelope masses of these stars should be large in order to be detected with the AKARI FIS. Imaging with higher sensitivity and higher spatial resolution is needed to detect and resolve, if present, any cool compact or extended emission associated with these evolved stars.

Accepted for publication in Astronomical Journal
Available from arXiv:1101.3450
and from http://www.iac.es/folleto/research/preprints/?c=view&pre_id=11005

Sirius B imaged in the mid-infrared: No evidence for a remnant planetary system

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Evidence is building that remnants of solar systems might orbit a large percentage of white dwarfs, as the polluted atmospheres of DAZ and DBZ white dwarfs indicate the very recent accretion of metal-rich material. (Zuckerman et al. 2010). Some of these polluted white dwarfs are found to have large mid-infrared excesses from close-in debris disks that are thought to be reservoirs for the metal accretion. These systems are coined DAZd white dwarfs (von Hippel et al. 2007).
Here we investigate the claims of Bonnet-Bidaud & Pantin (2008) that Sirius B, the nearest white dwarf to the Sun, might have an infrared excess from a dusty debris disk. Sirius B's companion, Sirius A is commonly observed as a mid-infrared photometric standard in the Southern hemisphere. We combine several years of Gemini/T-ReCS photometric standard observations to produce deep mid-infrared imaging in five ~ 10 μm filters (broad N + 4 narrowband), which reveal the presence of Sirius B. Our photometry is consistent with the expected photospheric emission such that we constrain any mid-infrared excess to $< 10\%$ of the photosphere. Thus we conclude that Sirius B does not have a large dusty disk, as seen in DAZd white dwarfs.

Accepted for publication in Astrophysical Journal
Available from arXiv:1101.4314

The influence of binarity on dust obscuration events in the planetary nebula M 2-29 and its analogues

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The central star of the planetary nebula (CSPN) M 2-29 shows an extraordinary R Coronae Borealis-like fading event in its optical lightcurve. The only other CSPN to show these events are CPD-568032 (Hen 3-1333) and V651 Mon (NGC 2346). Dust cloud formation in the line of sight appears responsible but the exact triggering mechanism is not well understood. Understanding how planetary nebulae (PNe) trigger dust obscuration events may help understand the same process in a wide range of objects including Population-I WC9 stars, symbiotic stars and perhaps Asymptotic Giant Branch (AGB) stars with long secondary periods (LSPs). A binary scenario involving an eccentric, wide companion that triggers dust formation via interaction at periastron is a potential explanation that has been suggested for LSP variables. Model fits to the lightcurves of CPD-568032 and M 2-29 show the dust forms in excess of 70 AU at the inner edge of a dust disk. In the case of CPD-568032 this radius is far too large to coincide with a binary companion trigger, although a binary may have been responsible for the formation of the dust disk. We find no direct evidence to support previous claims of binarity in M 2-29 either from the OGLE lightcurve or deep medium-resolution VLT FLAMES spectroscopy of the CSPN. We classify the CSPN as Of(H) with $T_{\rm eff} = 50 \pm 10$ kK and $\log g = 4.0 \pm 0.3$. We find a mean distance of 7.4 ± 1.8 kpc to M 2-29 at which the $M_{\rm V} = -0.9$ mag CSPN could potentially hide a subgiant luminosity or fainter companion. A companion would help explain the multiple similarities with D′-type symbiotic stars whose outer nebulae are thought to be bona-fide PNe. The 7.4 kpc distance, oxygen abundance of 8.3 dex and Galactic coordinates ($\ell = 4.0$, $b = -3.0$) prove that M 2-29 is a Galactic Bulge PN and not a Halo PN as commonly misconceived.

Accepted for publication in A&A
Available from arXiv:1101.4959

Magnetic fields in evolved stars: Imaging the polarized emission of high-frequency SiO masers

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We present Submillimeter Array observations of high frequency SiO masers around the supergiant VX Sgr and the semi-regular variable star W Hya. The $J = 5 - 4$, $v = 1$ ^{28}SiO and $v = 0$ ^{29}SiO masers of VX Sgr are shown to be highly linearly polarized with a polarization from $\sim$ 5–60%. Assuming the continuum emission peaks at the stellar position, the masers are found within $\sim$ 60 mas of the star, corresponding to $\sim$ 100 AU at a distance of 1.57 kpc. The linear polarization vectors are consistent with a large scale magnetic field, with position and inclination angles

similar to that of the dipole magnetic field inferred in the H_2O and OH maser regions at much larger distances from the star. We thus show for the first time that the magnetic field structure in a circumstellar envelope can remain stable from a few stellar radii out to $\sim$ 1400 AU. This provides further evidence supporting the existence of large scale and dynamically important magnetic fields around evolved stars. Due to a lack of parallactic angle coverage, the linear polarization of masers around W Hya could not be determined. For both stars we observed the ^{28}SiO and ^{29}SiO isotopologues and find that they have a markedly different distribution and that they appear to avoid each other. Additionally, emission from the SO $5_5 - 4_4$ line was imaged for both sources. Around W Hya we find a clear offset between the red- and blue-shifted SO emission. This indicates that W Hya is likely host to a slow bipolar outflow or a rotating disk-like structure.

Accepted for publication in The Astrophysical Journal
Available from arXiv:1101.1960

SiO maser spectra of V407 Cyg after the 2010 March outburst

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We report on the time variation of SiO maser emission from the symbiotic stellar system V407 Cyg after the classical nova outburst on 2010 March 10. Although both the SiO $J = 1 - 0$ $v = 1$ and 2 lines at 43.122 and 42.821 GHz were found previously in the envelope of a Mira in the binary system, only weak emission of the $J = 1 - 0$ $v = 2$ line has continuously been detectable after the nova outburst. The line profile exhibited a dramatic change several weeks after the burst; the component on the higher-velocity side of the systemic velocity disappeared two weeks after the burst, and a new persistent component appeared on the lower-velocity side later. These observations indicate that the SiO emitting regions are wiped out in a time scale of two weeks by the nova shock, but a part of the masing region is quickly replenished by cool molecular gases expelled by the mira pulsation.

Accepted for publication in PASJ 63, no.1 (Feb. 25 issue)
Available from arXiv:1012.0625

Chemical abundances for evolved stars in M 5: Lithium through thorium

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We present analysis of high-resolution spectra of a sample of stars in the globular cluster M 5 (NGC 5904). The sample includes stars from the red giant branch (RGB; seven stars), the red horizontal branch (two stars), and the asymptotic giant branch (AGB; eight stars), with effective temperatures ranging from 4000 K to 6100 K. Spectra were obtained with the HIRES spectrometer on the Keck I telescope, with a wavelength coverage from 3700 Å to 7950 Å for the HB and AGB sample, and 5300 Å to 7600 Å for the majority of the RGB sample. We find offsets of some abundance ratios between the AGB and the RGB branches. However, these discrepancies appear to be due to analysis effects, and indicate that caution must be exerted when directly comparing abundance ratios between different evolutionary branches. We find the expected signatures of pollution from material enriched in the products of the hot hydrogen

burning cycles such as the CNO, Ne–Na, and Mg–Al cycles, but no significant differences within these signatures among the three stellar evolutionary branches especially when considering the analysis offsets. We are also able to measure an assortment of neutron-capture element abundances, from Sr to Th, in the cluster. We find that the neutron-capture signature for all stars is the same, and shows a predominately r-process origin. However, we also see evidence of a small but consistent extra s-process signature that is not tied to the light-element variations, pointing to a pre-enrichment of this material in the protocluster gas.

Published in The Astronomical Journal, 141, 62
Available from arXiv:1101.0832

The first confirmed Mira star in M 33

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We present photometry and moderate-resolution spectroscopy of the luminous red variable [HBS2006] 40671 originally detected as a possible nova in the galaxy M 33. We found that the star is a pulsating Mira-type variable with a long period of 665 days and an amplitude exceeding 7 mag in R band. [HBS2006] 40671 is the first confirmed Mira-type star in M 33. It is one of the most luminous Mira-type variables. In the K band its mean absolute magnitude is $M_{\rm K} = -9.5$, its bolometric magnitude measured in the maximum light is also extreme, $M_{\rm bol} = -7.4$. The spectral type of the star in the maximum is M2e–M3e. The heliocentric radial velocity of the star is -475 km s^{-1}. There is a big negative excess (-210 km s^{-1}) in radial velocity of [HBS2006] 40671 relative to the average radial velocity of stars in its neighborhood pointing at an exceptional peculiar motion of the star. All the extreme properties of the new Mira star make it important for further studies.

Accepted for publication in Monthly Notices of the Royal Astronomical Society
Available from arXiv:1101.2984

Conference Papers

Discovery of Iron in PG 1159 Stars

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The lack of Fe VII lines in PG 1159 stars had led to the conclusion that in some objects iron must be strongly depleted. We have now detected Fe X lines in FUSE spectra of the very hottest PG 1159 stars ($T_{\rm eff} = 150,000$–$200{,}000$ K; RX J2117.1+3412, K 1-16, NGC 246, Longmore 4). Surprisingly, we derive a solar iron abundance. It is conspicuous that they are among the most massive PG 1159 stars (0.71–0.82 $M_\odot$), in contrast to those objects for which strongest Fe-deficiency was claimed (0.53–0.56 $M_\odot$). Based on new Fe VIII line identifications in SOHO/SUMER UV spectra of the Sun, we were able to detect these lines in FUSE spectra of several "cooler" ($T_{\rm eff} < 150,000$ K) objects, among them is the prototype PG 1159−035. An abundance analysis is in progress.

Poster contribution, published in "17th European White Dwarf Workshop", AIP Conf. Proc., 1273, 75
Available from arXiv:1012.5228

HST/COS Spectroscopy of H 1504+65

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We present new ultraviolet spectra of the peculiar white dwarf (WD) H 1504+65, obtained with COS on *HST*. H 1504+65 is the hottest known WD ($T_{\rm eff}$ = 200,000 K) and has an atmosphere mainly composed of C and O, augmented with high amounts of Ne and Mg. This object is unique and the origin of its surface chemistry is completely unclear. We probably see the naked core of either a C–O WD or even a O–Ne–Mg WD. In the latter case, this would be the first direct proof that such WDs can be the outcome of single-star evolution. The new observations were performed to shed light on the origin of this mysterious object.

Oral contribution, published in "17th European White Dwarf Workshop", AIP Conf. Proc., 1273, 58
Available from arXiv:1012.5222

Rubidium-rich Asymptotic Giant Branch stars in the Magellanic Clouds

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The Magellanic Clouds (MCs) offer a unique opportunity to study the stellar evolution and nucleosynthesis of massive Asymptotic Giant Branch (AGB) stars in low metallicity environments where distances are known. Rubidium is a key element to distinguish between high mass AGB stars and low mass AGBs or other type of astronomical objects such as massive red supergiant stars. Theoretically, high mass AGBs are predicted to produce a lot of Rb. We present the discovery of massive Rb-rich AGB stars in the MCs, confirming for the first time that these stars also exist in other galaxies. Our findings show that these stars are generally brighter than the standard adopted luminosity limit ($M_{\rm bol} \sim -7.1$) for AGB stars. The observations of massive MC AGBs are qualitatively predicted by the present theoretical models. However, these theoretical models are far from matching the extremely high Rb overabundances observed. This might be related with an incomplete present understanding of the atmospheres of these stars.

Oral contribution, published in "Why galaxies care about AGB stars II"
Available from arXiv:1101.3515

Orbital evolution of planets around intermediate-mass giants

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Around low- and intermediate-mass (1.5–3 $M_\odot$) red giants, no planets have been found inside 0.6 AU. Such a paucity is not seen in the case of 1 $M_\odot$ main sequence stars. In this study, we examine the possibility that short-period planets were engulfed by their host star evolving off the main sequence. To do so, we have simulated the orbital evolution of planets, including the effects of stellar tide and mass loss, to determine the critical semimajor axis, $a_{\rm crit}$, beyond which planets survive the RGB expansion of their host star. We have found that $a_{\rm crit}$ changes drastically around 2 $M_\odot$: In the lower-mass range, $a_{\rm crit}$ is more than 1 AU, while $a_{\rm crit}$ is as small as about 0.2 AU in the higher-mass range. Comparison with measured semimajor axes of known planets suggests that there is a lack of planets that only planet engulfment never accounts for in the higher-mass range. Whether the lack is real affects our understanding of planet formation. Therefore, increasing the number of planet samples around evolved intermediate-mass stars is quite meaningful to confirm robustness of the lack of planets.

Poster contribution, published in "Planets beyond MS", 2010
Available from arXiv:1011.6606
and from http://www.sternwarte.uni-erlangen.de/conf2010/index2.html

The Pan-Pacific Planet Search: A southern hemisphere search for planets orbiting evolved massive stars

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The vast majority of known extrasolar planets orbit stars with a narrow range of masses (0.7–1.3 $M_\odot$). Recent years have seen rapid growth in our knowledge about the properties of planetary systems with host stars significantly more massive than the Sun. Planet formation models predict that giant planets are more common around higher-mass stars ($M_\star > 1.5$ $M_\odot$). However, these types of stars pose severe observational challenges while on the main sequence, resulting in a strong bias against them in current planet searches. Fortunately, it is possible to obtain high-precision Doppler velocities for these massive stars as they evolve off the main sequence and cool as subgiants. We describe the Pan-Pacific Planet Search, a survey of 170 subgiant stars using the 3.9m Anglo-Australian Telescope. In collaboration with J. Johnson's Keck survey of Northern "retired A stars," we are monitoring nearly every subgiant brighter than $V = 8$. This survey will provide critical statistics on the frequency and characteristics of planetary systems formed around higher-mass stars.

Oral contribution, published in "Planets Beyond the Main Sequence"
Available from arXiv:1101.4052

Infrared survey of pulsating giant stars in the spiral galaxy M 33: Dust production, star formation history, and galactic structure

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We introduce a near-IR monitoring campaign of the Local Group spiral galaxy M 33, carried out with the UK IR Telescope (UKIRT). The pulsating giant stars are identified and their distributions are used to derive the star formation rate as a function of age. We here present the star formation history for the central square kiloparsec. These stars are also important dust factories; we measure their dust production rates from a combination of our data with *Spitzer* Space Telescope mid-IR photometry.

Oral contribution, published in "Why AGB Stars Care About Galaxies II", Vienna 2010, eds. Franz Kerschbaum, Thomas Lebzelter and Bob Wing, ASP Conf.Ser.
Available from arXiv:1101.5271

The kinematics and morphology of PNe with close binary nuclei

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We have obtained images and long-slit, spatially resolved echelle spectra for twenty four planetary nebulae (PNe) that have confirmed close binary nuclei. The sample shows a variety of morphologies, however toroids or dense equatorial density enhancements are identified, both in the imagery and the spectra, as the common structural component. These toroids are thought to be the remnant fingerprints of the post common envelope phase. Based on the characteristics of the present sample we suggest a list of additional PNe that are likely to host close binary nuclei.

Oral contribution, published in "Asymmetric Planetary Nebulae V", Ebrary
Available from arXiv:1101.5653

Review Papers

The fate of planets

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As a star evolves off the Main Sequence, it endures major structural changes that are capable of determining the fate of the planets orbiting it. Throughout its evolution along the Red Giant Branch, the star increases its radius by two orders of magnitude. Later, during the Asymptotic Giant Branch, it loses most of its initial mass. Finally, during the Planetary Nebulae phase, it emits intense radiation before ultimately beginning its fade as a white dwarf. We show how the several competing processes (stellar mass-loss, gravitational and frictional drag, tidal forces, planet accretion and evaporation) affect the survival of planets around evolved stars.

Published in "Planetary Systems beyond the Main Sequence" (Invited Review)
Available from arXiv:1101.1773

Water maser emission in planetary nebulae

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Planetary nebulae (PMe) evolve from Asymptotic Giant Branch (AGB) stars after a brief post-AGB phase. Water maser emission is characteristic of oxygen-rich AGB stars, is observed in post-AGB stars, and, unexpectedly, has been detected in three PNe (IRAS 17347−3139, IRAS 18061−2505 and IRAS 19255+2123) where the physical conditions to generate water maser emission did not seem to exist. These three objects may be considered as the youngest PNe known up to date and, therefore, they are key objects to understand the formation of PNe. In addition, the existence of water maser emitting PNe allow us to study every phase in the AGB to PN transition using water maser emission which can be observed at very high spatial and spectral resolution. In this paper we review the properties of water maser emission in PNe, the existing observations of the three water maser emitting PNe and their implications in our understanding of PN formation and evolution.

Published in Lecture Notes and Essays in Astrophysics IV
Available from arXiv:1101.2837

Job Adverts

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see URL (deadline February 17th 2011)

Documents needed:

1. Passport copy
2. CV of our team and of the PI
3. CV of the candidate
4. Project to be developed
5. Copy of PhD certificate of the candidate

Interested candidates, please contact as soon as possible:
Carlos Abia: cabia@ugr.es + 34 958 249061
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See also http://www.micinn.es/portal/site/MICINN/menuitem.dbc68b34d11ccbd5d52ffeb801432ea0/?vgnextoid=3317b43c2747d210VgnVCM1000001d04140aRCRD&vgnextchannel=76c9282978ea0210VgnVCM1000001034e20aRCRD

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All the Best and Good Luck!!
Inma y Carlos

Carlos Abia: cabia@ugr.es + 34 958 249061
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PhD studentship at University of Denver (USA)

The Department of Physics and Astronomy at the University of Denver (DU) in Denver, CO, USA is seeking a motivated PhD student to work on observations and modelling of evolved stars.

The DU Stellar Evolution group has been conducting research using far-IR data acquired with *Spitzer*, AKARI, and *Herschel* Space Observatory to study the physics and chemistry of the circumstellar shells of evolved stars. Recently, we have obtained *Herschel* OT1 observing time to carry out a survey on high-excitation planetary nebulae (PI: T. Ueta) to obtain spatially-resolved spectroscopic data in the *Herschel* (PACS/SPIRE) wavelengths. These data will add another dimension to the currently existing research based on broad-band far-IR data taken with *Spitzer*, AKARI, and *Herschel*. The successful candidate will have the opportunity to carry out a PhD research using these data sets under the supervision by Toshiya Ueta.

A bachelor's or master's degrees degree in Astronomy or Physics is required for this position, together with an excellent academic track record. Undergraduate research experience is a plus. Interested candidates are asked to contact Toshiya Ueta (tueta(at)du.edu) and start the standard application procedure at DU immediately (visit http://www.du.edu/apply/graduates/applicationrequirements.html). Selection process will commence shortly. The successful candidate will start in September 1st, 2011, with TA duties. An exceptionally successful candicate can start with RA duties. The studentship can be supported by existing funding to the group for multiple years.

For further information, please contant: Toshiya Ueta, Assistant Professor, Dept. of Physics and Astronomy, University of Denver, CO 80208, USA, phone: 303-871-3523, fax: 303-871-4405, email: tueta(at)du.edu (replace (at) with @).

See also http://www.du.edu/nsm/departments/physicsandastronomy/

1-year fellowship in Padova (Italy)

A 1-year fellowship to study the "Observational constraints to the evolution of AGB stars" is being offered at the Department of Astronomy of the Padova University. The main goal is the analysis of the photometric data regarding AGB stars in nearby resolved galaxies, obtained from several ground-based telescopes and *HST*, in the light of theoretical models for the TP-AGB evolution. Applications require a CV, a list of publications, and 2 letters of recommendation. The deadline is 17 February 2011. We encourage potential applicants to contact Paola Marigo at paola.marigo@unipd.it for more detailed instructions.

See also http://dipastro.pd.astro.it/ricerca/posizioni.html