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Editors: Jacco van Loon and Albert Zijlstra

Editorial

Dear Colleagues,

It is our pleasure to present you the 139$^{\rm th}$ issue of the AGB Newsletter. There's a lot to read, including a series of papers on binaries with M-type giants from the Hipparcos catalogue, on discs around evolved giants and white dwarfs, nice new constraints on the initial mass–final mass relation from white dwarfs in the beautiful Praesepe cluster by Sarah Casewell and her collaborators, studies on nucleosynthesis and mixing processes, and several extra-galactic studies in which AGB stars and PNe are used to learn more about the structure and evolution of their host galaxies.

There is an exciting opportunity for a PhD position in the wonderful Andalusian city of Granada, to investigate supernova progenitors and AGB stars.

No less appealing, this year's Joint European and National Astronomy Meeting, in Hertfordshire (UK), features a symposium on "The life cycle of dust".

The next issue will be distributed on the 1$^{\rm st}$ of March 2009; the deadline for contributions is the 28$^{\rm th}$ of February.

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

Do planets form in discs surrounding evolved stars or stellar remnants?

Reactions to this statement or suggestions for next month's statement can be e-mailed to agbnews@astro.keele.ac.uk (please state whether you wish to remain anonymous)

Refereed Journal Papers

The role of massive AGB stars in the early Solar System composition

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We demonstrate that a massive asymptotic giant branch (AGB) star is a good candidate as the main source of short-lived radionuclides in the early solar system. Recent identification of massive (4–8 $M_{\odot}$) AGB stars in the Galaxy, which are both lithium- and rubidium-rich, demonstrates that these stars experience proton captures at the base of the convective envelope (hot bottom burning), together with high-neutron density nucleosynthesis with ^{22}Ne as a neutron source in the He shell and efficient dredge-up of the processed material. A model of a 6.5 solar masses star of solar metallicity can simultaneously match the abundances of ^{26}Al, ^{41}Ca, ^{60}Fe, and ^{107}Pd inferred to have been present in the solar nebula by using a dilution factor of 1 part of AGB material per 300 parts of original solar nebula material, and taking into account a time interval between injection of the short-lived nuclides and consolidation of the first meteorites equal to 0.53 Myr. Such a polluting source does not overproduce ^{53}Mn, as supernova models do, and only marginally affects isotopic ratios of stable elements. It is usually argued that it is unlikely that the short-lived radionuclides in the early solar system came from an AGB star because these stars are rarely found in star forming regions, however, we think that further interdisciplinary studies are needed to address the fundamental problem of the birth of our solar system.

Accepted for publication in Meteoritics and Planetary Science (MAPs)
Available from arXiv:0812.4358
and from http://www.iac.es/folleto/research/preprints/?c=view&pre_id=8040

Electron Temperatures of Planetary Nebulae Determined from the He I Discontinuities

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We have used the He I discontinuities at 3421 Å to determine the electron temperatures, designated $T_{\rm e}$(He I), for a sample of five Galactic planetary nebulae (PNe). We compared $T_{\rm e}$(He I) with the electron temperatures derived from the hydrogen Balmer jump at 3646 Å, designated $T_{\rm e}$(H I), and found that $T_{\rm e}$(He I) are generally lower than $T_{\rm e}$(H I). There are two possible interpretations, a) the presence of substantial He^{2+} zone, or b) the presence of hydrogen-deficient cold clumps within diffuse nebulae. A series of photoionization models were constructed to test the two scenarios.

We found that the observed T_e(He I)/T_e(H I) discrepancies are beyond the predictions of chemically homogeneous models. Our modelling shows that the presence of a small amount of hydrogen-deficient inclusions seems to be able to reproduce the observed intensities of He I discontinuities. We stress the value of He I discontinuities in investigating nebular physical conditions. Albeit with some observational and technical limitations, He I discontinuities should be considered in future modelling work.

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Available from arXiv:0901.1411

The detection of infrared SiS bands in spectra of S stars

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We present Spitzer spectra of S stars, which are cool evolved stars with a C/O ratio near unity, some of which have enhanced s-process abundances. We present the detection of a strong and unusual band in the mid-infrared, at 13 μm, within the N-band window. Using quantum-chemically calculated line lists, and model spectra, we identify this band as the fundamental rovibrational band of SiS. Detection of the overtone band at 6.7 μm confirms the identification. Fitting the line profile shows that the molecule is located in relatively cool layers, at $T \sim 1500$ K. We discuss these results in the context of chemical equilibrium models. The observed strength of these bands in the cool S stars makes them a promising observational diagnostic tool for studying the atmospheres of brown dwarfs and exoplanets.

Published in The Astrophysical Journal Letters
Available from http://www.iop.org/EJ/abstract/-search=60519354.1/1538-4357/690/2/L122

Spectroscopic binaries among Hipparcos M giants I. Data, orbits, and intrinsic variations

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This paper is a follow-up of the vast effort to collect radial velocity data for stars belonging to the Hipparcos survey. We aim at extending the orbital data available for binaries with M giant primaries. The data will be used in the companion papers of this series to (i) derive the binary frequency among M giants and compare it to that of K giants (Paper II), and (ii) analyse the eccentricity-period diagram and the mass-function distribution (Paper III). Keplerian solutions are fitted to radial-velocity data. However, for several stars, no satisfactory solution could be found, despite the fact that the radial-velocity standard deviation is larger than the instrumental error, because M giants suffer from

intrinsic radial-velocity variations due to pulsations. We show that these intrinsic radial-velocity variations can be linked with both the average spectral-line width and the photometric variability. We present an extensive collection of spectroscopic orbits for M giants, with 12 new orbits, plus 17 from the literature. Moreover, to illustrate the fact that the large radial-velocity jitter present in Mira and semi-regular variables may easily be confused with orbital variations, we also present examples of pseudo-orbital variations (in S UMa, X Cnc and possibly in HD 115521, a former IAU radial-velocity standard). Because of this difficulty, M giants involving Mira variables were excluded from our monitored sample. We finally show that the majority of M giants detected as X-ray sources are actually binaries.

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Spectroscopic binaries among Hipparcos M giants II. Binary frequency

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This paper is the second one in a series devoted to the study of properties of binaries involving M giants. The binary frequency of field M giants is derived and compared with the binary fraction of K giants. Diagrams of the CORAVEL spectroscopic parameter Sb (measuring the average line-width) vs. radial-velocity standard deviation for our samples are used to define appropriate binarity criteria. These then serve to extract the binarity fraction among the M giants. Comparison is made to earlier data on K giants binarity frequency. The Sb parameter is discussed in relation to global stellar parameters and the Sb vs. stellar radius relation is used to identify fast rotators. We find that the spectroscopic binary detection rate among field M giants, in a sample with a low number of velocity measurements (~ 2), unbiased toward earlier known binaries, is 6.3%. This is less than half of the analogous rate for field K giants, likely resulting from a real difference. This difference originates in the greater difficulty of finding binaries among M giants because of their smaller orbital velocity amplitudes and larger intrinsic jitter and in the different distributions of K and M giants in the eccentricity–period diagram. A larger detection rate was obtained in a smaller M giant sample with more radial velocity measurements per object: 11.1% confirmed plus 2.7% possible binaries. The CORAVEL spectroscopic parameter Sb was found to correlate better with the stellar radius than with either luminosity or effective temperature separately. Two outliers of the Sb vs. stellar radius relation, HD 190658 and HD 219654, have been recognized as fast rotators. The rotation is companion-induced, as both objects turn out to be spectroscopic binaries.

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Spectroscopic binaries among Hipparcos M giants III. The eccentricity-period diagram and mass-transfer signatures

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This paper is the third one in a series devoted to studying the properties of binaries involving M giants. We use a new set of orbits to construct the first (e–$\log P$) diagram of an extensive sample of M giant binaries, to obtain their

mass-function distribution, and to derive evolutionary constraints for this class of binaries and related systems. The orbital properties of binaries involving M giants were analysed and compared with those of related families of binaries (K giants, post-AGB stars, barium stars, Tc-poor S stars). The orbital elements of post-AGB stars and M giants are not different, which may very indicate that, for the considered sample of post-AGB binaries, the post-AGB star left the AGB at quite an early stage (M4 or so). Neither are the orbital elements of post-mass-transfer binaries like barium stars very different from those of M giants, suggesting that the mass transfer did not alter the orbital elements much, contrary to current belief. Finally, we show that binary systems with $e < 0.4 \log P - 1$ (with periods expressed in days) are predominantly post-mass-transfer systems, because (i) the vast majority of barium and S systems match this condition, and (ii) these systems have companion masses peaking around 0.6 $M_\odot$, as expected for white dwarfs. The latter property has been shown to hold as well for open-cluster binaries involving K giants, for which a lower bound on the companion mass may easily be set.

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Thermohaline mixing in super-AGB stars

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We present the first study of the effects of thermohaline mixing on the structure and evolution of solar composition super AGB (SAGB) stars in the mass range 9–11 $M_\odot$. Stellar models that include a diffusive treatment of thermohaline mixing and different mixing efficiencies are computed and analyzed. In SAGB stars, thermohaline mixing comes into play after carbon has ignited off-center and significantly affects the propagation of the flame. In the radiative layers located below the convective carbon burning zone, a molecular weight inversion is created allowing for an efficient transport of chemicals. The outward diffusion of ^{12}C from the CO-rich core into the flame depletes the burning front of fuel and causes the extinction of the flame before it reaches the center. As a consequence unburnt amounts of carbon as high as 2–5% in mass are left at the center of the star. During the subsequent thermally pulsing SAGB phase, the high temperature at the base of the convective envelope prevents the development of thermohaline instabilities associated with ^{3}He burning as recently found in low-mass red giant stars. Contrarily to low-mass RGB stars, thermohaline mixing is unable to alter the surface composition of SAGB stars. We also emphasize that if the SAGB star evolves into an electron-capture supernovae, the 12C left in the core may alter the hydrodynamical explosion and modify the explosive nucleosynthesis.

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Mid-IR period-magnitude relations for AGB stars

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Asymptotic Giant Branch variables are found to obey period-luminosity relations in the mid-IR similar to those seen at K_s (2.14 μm), even at 24 μm where emission from circumstellar dust is expected to be dominant. Their loci in the

M, $\log P$ diagrams are essentially the same for the LMC and for NGC 6522 in spite of different ages and metallicities. There is no systematic trend of slope with wavelength. The offsets of the apparent magnitude vs. $\log P$ relations imply a difference between the two fields of 3.8 in distance modulus. The colours of the variables confirm that a principal period with $\log P > 1.75$ is a necessary condition for detectable mass-loss. At the longest observed wavelength, 24 μm, many semi-regular variables have dust shells comparable in luminosity to those around Miras. There is a clear bifurcation in LMC colour-magnitude diagrams involving 24 μm magnitudes.

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Tangential Motions and Spectroscopy within NGC 6720, the Ring Nebula

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We have combined recent Hubble Space Telescope WFPC2 images in the [O III] 5007 Å and [N II] 6583 Å lines with similar images made 9.557 years earlier to determine the motion of the Ring Nebula within the plane of the sky. Scaled ratio images argue for homologous expansion, that is, larger velocities scale with increasing distance from the central star. The rather noisy pattern of motion of individual features argues for the same conclusion and that the silhouetted knots move at the same rate as the surrounding gas. These tangential velocities are combined with information from a recent high resolution radial velocity study to determine a dynamic distance, which is in basic agreement with the distance determined from the parallax of the central star. We have also obtained very high signal to noise ratio moderate resolution spectra (9.4 Å) along the major and minor axes of the nebula and from this determined the electron temperatures and density in the multiple ionization zones present. These results confirm the status of the Ring Nebula as one of the older planetary nebulae, with a central star transitioning to the white dwarf cooling curve.

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Infrared Signatures of Disrupted Minor Planets at White Dwarfs

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Spitzer Space Observatory IRAC and MIPS photometric observations are presented for 20 white dwarfs with $T < 20,000$ K and metal-contaminated photospheres. A warm circumstellar disk is detected at GD 16 and likely at PG 1457−086, while the remaining targets fail to reveal mid-infrared excess typical of dust disks, including a number of heavily polluted stars. Extending previous studies, over 50% of all single white dwarfs with implied metal accretion rates $\mathrm{d}M/\mathrm{d}t > 3 \times 10^8$ g s^{-1} display a warm infrared excess from orbiting dust; the likely result of a tidally-destroyed minor planet. This benchmark accretion rate lies between the dust production rates of 1×10^6 g s^{-1} in the solar system zodiacal cloud and 1×10^{10} g s^{-1} often inferred for debris disks at main sequence A-type stars. It is estimated that between 1% and 3% of all single white dwarfs with cooling ages less than around 0.5 Gyr possess circumstellar dust, signifying an underlying population of minor planets.

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Discovery of two distinct red clumps in NGC 419: a rare snapshot of a cluster at the onset of degeneracy

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Colour–magnitude diagrams (CMD) of the SMC star cluster NGC 419, derived from HST/ACS data, reveal a well-delineated secondary clump located below the classical compact red clump typical of intermediate-age populations. We demonstrate that this feature belongs to the cluster itself, rather than to the underlying SMC field. Then, we use synthetic CMDs to show that it corresponds very well to the secondary clump predicted to appear as a result of He-ignition in stars just massive enough to avoid electron-degeneracy settling in their H-exhausted cores. The main red clump instead is made of the slightly less massive stars which passed through electron-degeneracy and ignited He at the tip of the RGB. In other words, NGC 419 is the rare snapshot of a cluster while undergoing the fast transition from classical to degenerate H-exhausted cores. At this particular moment of a cluster's life, the colour distance between the main sequence turn-off and the red clump(s) depends sensitively on the amount of convective core overshooting, Λ_c. By coupling measurements of this colour separation with fits to the red clump morphology, we are able to estimate simultaneously the cluster mean age ($1.35^{+0.11}_{-0.04}$ Gyr) and overshooting efficiency ($\Lambda_c = 0.47^{+0.14}_{-0.04}$). Therefore, clusters like NGC 419 may constitute important marks in the age scale of intermediate-age populations. After eye inspection of other CMDs derived from HST/ACS data, we suggest that the same secondary clump may also be present in the LMC clusters NGC 1751, 1783, 1806, 1846, 1852, and 1917.

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On the formation of hot DQ white dwarfs

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We present the first full evolutionary calculations aimed at exploring the origin of hot DQ white dwarfs. These calculations consistently cover the whole evolution from the born-again stage to the white dwarf cooling track. Our calculations provide strong support to the diffusive/convective-mixing picture for the formation of hot DQs. We find that the hot DQ stage is a short-lived stage and that the range of effective temperatures where hot DQ stars are found can be accounted for by different masses of residual helium and/or different initial stellar masses. In the frame of this scenario, a correlation between the effective temperature and the surface carbon abundance in DQs should be expected, with the largest carbon abundances expected in the hottest DQs. From our calculations, we suggest that most of the hot DQs could be the cooler descendants of some PG 1159 stars characterized by He-rich envelopes markedly smaller than those predicted by the standard theory of stellar evolution. At least for one hot DQ, the high-gravity white dwarf SDSS J142625.70+575218.4, an evolutionary link between this star and the massive PG 1159 star H 1504+65 is plausible.

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Carbon-rich RR Lyr Type Stars

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We have derived CNO abundances in 12 RR Lyrae stars. Four stars show [C/Fe] near 0.0 and two stars show [C/Fe] = 0.52 and 0.65. Red giant branch stars, which are known to be the predecessors of RR Lyrae stars, generally show a deficiency of carbon due to proton captures during their evolution from the main sequence up the giant branch. We suggest that the enhancement of carbon is due to production during the helium flash combined with mixing to the surface by vigorous convection induced by the flash itself.

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Enhanced production of barium in low-mass stars: evidence from open clusters

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We report the discovery of a trend of increasing barium abundance with decreasing age for a large sample of Galactic open clusters. The observed pattern of [Ba/Fe] vs. age can be reproduced with a Galactic chemical evolution model only assuming a higher Ba yield from the *s*-process in low-mass stars than the average one suggested by parametrized models of neutron-capture nucleosynthesis. We show that this is possible in a scenario where the efficiency of the extra-mixing processes producing the neutron source ^{13}C is anti-correlated with the initial mass, with a larger efficiency for lower masses. This is similar to the known trend of extended mixing episodes acting in H-rich layers and might suggest a common physical mechanism.

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Serendipitous XMM-Newton Detection of X-ray Emission from the Bipolar Planetary Nebula Hb 5

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We report the serendipitous detection by the XMM-Newton X-ray Observatory of an X-ray source at the position of the Type I (He- and N-rich) bipolar planetary nebula Hb 5. The Hb 5 X-ray source appears marginally resolved. While the small number of total counts (~ 170) and significant off-axis angle of the X-ray source ($\sim 7.8'$) precludes a definitive spatial analysis, the morphology of the X-ray emission appears to trace the brightest features seen in optical images of Hb 5. The X-ray spectrum is indicative of a thermal plasma at a temperature between 2.4 and 3.7 MK and appears to display strong Neon emission. The inferred X-ray luminosity is $L_{\rm X} = 1.5 \times 10^{32}$ erg s^{-1}. These results suggest that the detected X-ray emission is dominated by shock-heated gas in the bipolar nebula, although we cannot rule out the presence of a point-like component at the position of the central star. The implications for and

correspondence with current models of shock-heated gas in planetary nebulae is discussed.

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CNO abundances of HdC and RCB stars: a view of the nucleosynthesis in a white dwarf merger

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We present high-resolution ($R \sim 50,000$) observations of near-IR transitions of CO and CN of the five known hydrogen-deficient carbon (HdC) stars and four R Coronae Borealis (RCB) stars. We perform an abundance analysis of these stars by using spectrum synthesis and state-of-the-art MARCS model atmospheres for cool hydrogen-deficient stars. Our analysis confirms reports by Clayton and colleagues that those HdC stars exhibiting CO lines in their spectrum and the cool RCB star S Aps are strongly enriched in ^{18}O (with ^{16}O/^{18}O ratios ranging from 0.3 to 16). Nitrogen and carbon are in the form of ^{14}N and ^{12}C, respectively. Elemental abundances for CNO are obtained from CI, C_2, CN, and CO lines. Difficulties in deriving the carbon abundance are discussed. Abundances of Na from Na I lines and S from S I lines are obtained. Elemental and isotopic CNO abundances suggest that HdC and RCB stars may be related objects and that they probably formed from a merger of a He white dwarf with a C-O white dwarf.

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Binary Planetary Nebulae Nuclei towards the Galactic Bulge. I. Sample Discovery, Period Distribution and Binary Fraction

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Binarity has been hypothesised to play an important, if not ubiquitous, role in the formation of planetary nebulae (PNe). Yet there remains a severe paucity of known binary central stars required to test the binary hy pothesis and to place strong constraints on the physics of the common-envelope (CE) phase of binary stellar evolution. Large photometric surveys offer an unrivalled opportunity to efficiently discover many binary central stars. We have combined photometry from the OGLE microlensing survey with the largest sample of PNe towards the Galactic Bulge to systematically search for new binaries. A total of 21 periodic binaries were found thereby more than doubling the known sample. The orbital period distribution was found to be best described by CE population synthesis models when no correlation between primary and secondary masses is assumed for the initial mass ratio dist ribution. A comparison with post-CE white dwarf binaries indicates both distributions are representative of the true post-CE period distribution with most binaries exhibiting periods less than one day. An estimated close binary fraction of 12–21% is derived and is the first robust and independent validation of the prevailing 10–15% fraction estimated by

Bond (2000). This suggests that binarity is not a precondition for the formation of PNe and that close binaries do not play a dominant role in the shaping of nebular morphologies. Systematic effects and biases of the survey are discussed with implications for future photometric surveys.

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The $\Sigma - D$ Relation for Planetary Nebulae

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We present an extended analysis of the relation between radio surface brightness and diameter — the so-called $\Sigma - D$ relation for planetary nebulae (PNe). We revise our previous derivation of the theoretical $\Sigma - D$ relation for the evolution of bremsstrahlung surface brightness in order to include the influence of the fast wind from the central star. Different theoretical forms are derived: $\Sigma \propto D^{-1}$ for the first and second phases of evolution and $\Sigma \propto D^{-3}$ for the final stage of evolution. Also, we analyzed several different Galactic PN samples. All samples are influenced by severe selection effects, but Malmquist bias seems to be less influential here than in the supernova remnant (SNR) samples. We derived empirical $\Sigma - D$ relations for 27 sample sets using 6 updated PN papers from which an additional 21 new sets were extracted. Twenty four of these have a trivial form of $\beta \approx 2$. However, we obtain one empirical $\Sigma - D$ relation that may be useful for determining distances to PNe. This relation is obtained by extracting a recent nearby (< 1 kpc) Galactic PN sample.

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Empirical Abundance Scaling Laws and Implications for the Gamma-Process in Core-Collapse Supernovae

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Analyzing the solar system abundances, we have found two empirical abundance scaling laws concerning the p- and s-nuclei with the same atomic number. The first scaling is s/p ratios are almost constant over a wide range of the atomic number, where the p-nculei are lighter than the s-nuclei by two or four neutrons. The second scaling is p/p ratios are almost constant, where the second p-nuclei are lighter than the first p-nucleus by two neutrons. These scalings are a piece of evidence that most p-nuclei are dominantly synthesized by the γ-process in supernova explosions. The scalings lead to a novel concept of "universality of γ-process" that the s/p and p/p ratios of nuclei produced by individual γ-processes are almost constant, respectively. We have calculated the ratios by γ-process based on core-collapse

supernova explosion models under various astrophysical conditions and found that the scalings hold for materials produced by individual γ-processes independent of the astrophysical conditions assumed. The universality originates from three mechanisms: the shifts of the γ-process layers to keep their peak temperature, the weak *s*-process in pre-supernovae, and the independence of the s/p ratios of the nuclear reactions. The results further suggest an extended universality that the s/p ratios in the γ-process layers are not only constant but also centered on a specific value of 3. With this specific value and the first scaling, we estimate that the ratios of *s*-process abundance contributions from the AGB stars to the massive stars are almost 6.7 for the *s*-nuclei of A $>$ 90. We find that large enhancements of s/p ratios for Ce, Er, and W are a piece of evidence that the weak *s*-process actually occurred before SNe.

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High resolution optical spectroscopy of Praesepe white dwarfs

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We present the results of a high resolution optical spectroscopic study of nine white dwarf candidate members of Praesepe undertaken with the VLT and UVES. We find, contrary to a number of previous studies, that WD 0836+201 (LB 390, EG 59) and WD 0837+199 (LB 393, EG 61) are magnetic and non-magnetic white dwarfs respectively. Subsequently, we determine the radial velocities for the eight non-magnetic degenerates and provide compelling evidence that WD 0837+185 is a radial velocity variable and possibly a double-degenerate system. We also find that our result for WD 0837+218, in conjunction with its projected spatial location and position in initial mass–final mass space, argues it is more likely to be a field star than a cluster member. After eliminating these two white dwarfs, and WD0836+199 which has no clean SDSS photometry, we use the remaining 5 stars to substantiate modern theoretical mass-radius relations for white dwarfs. In light of our new results we re-examine the white dwarf members of Praesepe and use them to further constrain the initial mass–final mass relation. We find a a near monotonic IFMR, which can still be adequately represented by simple linear function with only one outlier which may have formed from a blue straggler star.

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Dust Formation in a Galaxy with Primitive Abundances

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Interstellar dust plays a crucial role in the evolution of galaxies. It governs the chemistry and physics of the interstellar medium. In the local universe, dust forms primarily in the ejecta from stars, but its composition and origin in galaxies at very early times remain controversial. We report observational evidence of dust forming around a carbon star in a

nearby galaxy with a low abundance of heavy elements, 25 times lower than the solar abundance. The production of dust by a carbon star in a galaxy with such primitive abundances raises the possibility that carbon stars contributed carbonaceous dust in the early universe.
The paper is available with no subscription using the link below.

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The planetary nebula population of M 33 and its metallicity gradient: A look into the galaxy's distant past

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The Planetary Nebula (PN) population of M 33 is studied via multi-fiber spectroscopy with Hectospec at the MMT. In this paper we present the spectra of 102 PNe, whereas plasma diagnostic and chemical abundances were performed on the 93 PNe where the necessary diagnostic lines were measured.
About 20% of the PNe are compatible with being Type I; the rest of the sample is the progeny of an old disk stellar population, with main sequence masses $M < 3$ $M_\odot$ and ages $t > 0.3$ Gyr.
By studying the elemental abundances of the PNe in the M 33 disk we were able to infer that: (1) there is a tight correlation between O/H and Ne/H, broadly excluding the evolution of oxygen; (2) the average abundances of the α-elements are consistent with those of H II regions, indicating a negligible global enrichment in the disk of M 33 from the epoch of the formation of the PN progenitors to the present time; (3) the radial oxygen gradient across the M 33 disk has a slope of -0.031 ± 0.013 dex kpc^{-1}, in agreement, within the errors, with the corresponding gradient derived from H II regions. Our observations do not seem to imply that the metallicity gradient across the M 33 disk has flattened considerably with time. We report also the discovery of a PN with Wolf-Rayet features, PN 039, belonging the class of late [WC] stars.

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Kinematic Evidence for Halo Substructure in Spiral Galaxies

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We present the results of a kinematic study of planetary nebulae in the extreme outskirts of two spiral galaxies, M 83 (NGC 5236) and M 94 (NGC 4736). We find that in the inner regions of the galaxies, the vertical velocity dispersion (σ_z) falls off exponentially with the light, as expected for a constant mass-to-light ratio, constant thickness disk. However, starting at four optical scale lengths, σ_z asymptotes out at roughly 20 km s^{-1}. Our analysis finds evidence for significant flaring in the outer regions as well, especially in M 94. These observations are in excellent agreement with predictions derived from models of disk heating by halo substructure, and demonstrate how kinematic surveys in the outer disk of spirals can be used to test hierarchical models of galaxy formation.

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A Substantial Dust Disk Surrounding an Actively Accreting First-Ascent Giant Star

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We report identification of the first unambiguous example of what appears to be a new class of first-ascent giant stars that are actively accreting gas and dust and that are surrounded by substantial dusty disks. These old stars, who are nearing the end of their lives, are experiencing a rebirth into characteristics typically associated with newborn stars. The F2-type first-ascent giant star TYC 4144 329 2 is in a wide separation binary system with an otherwise normal G8 IV star, TYC 4144 329 1. From Keck near-infrared imaging and high-resolution spectroscopy we are able to determine that these two stars are ∼1 Gyr old and reside at a distance of ∼550 pc. One possible explanation for the origin of the accreting material is common-envelope interaction with a low-mass stellar or sub-stellar companion. The gaseous and dusty material around TYC 4144 329 2, as it is similar to the primordial disks observed around young classical T Tauri stars, could potentially give rise to a new generation of planets and/or planetesimals.

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A holistic approach to carbon-enhanced metal-poor stars

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Carbon-Enhanced Metal-Poor (CEMP) stars are known to be the direct witnesses of the nucleosynthesis of the first low- and intermediate-mass stars, because they have been polluted by a now-extinct AGB star. To put CEMP stars in a broad context, we collect abundances for about 180 stars of various metallicities (from solar down to [Fe/H]= −4), luminosity classes (dwarfs and giants), and abundance patterns (C-rich and poor, Ba-rich and poor, etc.), from our own sample and from literature. First, we introduce a class of CEMP stars sharing the properties of CEMP-s stars and CEMP-no stars. We also show that there is a strong correlation between Ba and C in the s-only CEMP stars. This strongly points at the operation of the ^{13}C neutron source in low-mass AGB stars. For the CEMP-rs stars (enriched with elements from both the s- and r-processes), the correlation of the N abundances with abundances of heavy elements from the 2nd and 3rd s-process peaks bears instead the signature of the ^{22}Ne neutron source. Adding to the fact that CEMP-rs stars exhibit O and Mg enhancements, we conclude that extremely hot conditions prevailed during the thermal pulses of the AGB stars. We also notice that abundances are not affected by the evolution of the CEMP-rs star itself (especially by the first dredge-up). This implies that mixing must have occurred while the star was on the main sequence and that a large amount of matter must have been accreted. Finally, we argue that CEMP-no stars (with no overabundances for the neutron-capture elements) are likely the extremely metal-poor counterparts of CEMP neutron-capture-rich stars. We also show that the C enhancement in CEMP-no stars declines with metallicity at extremely low metallicity ([Fe/H]< −3.2). This trend is not predicted by any of the current AGB models.

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A Spitzer Study of 21 and 30 μm Emission in Several Galactic Carbon-rich Proto-Planetary Nebulae

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We have carried out mid-infrared spectroscopy of seven Galactic proto-planetary nebulae (PPNs) using the Spitzer Space Telescope. They were observed from 10–36 μm at relatively high spectral resolution, $R \sim 600$. The sample was chosen because they all gave some evidence in the visible of a carbon-rich chemistry. All seven of the sources show the broad, unidentified 21 μm emission feature; three of them are new detections (IRAS 06530−0213, 07430+1115, and 19477+2401) and the others are observed at higher S/N than in previous spectra. These have the same shape and central wavelength (20.1 μm) as found in the ISO spectra of the brighter PPNs. The 30 μm feature was seen in all seven objects. However, it is not resolved into two separate features (26 and 33 μm) as was claimed on the basis of ISO spectra, which presumably suffered from the noisy detector bands in this region. All showed the infrared aromatic bands (AIB) at 11.3, 12.4, and 13.3 μm. Five of these also appear to have the C_2H_2 molecular band at 13.7 μm, one in absorption and four in emission. This is extremely rare, with only one other evolved star, IRC +10216, in which C_2H_2 emission has been observed. Four also possessed a broad, unidentified emission feature at 15.8 μm that may possibly be related to the 21 μm feature. Model fits were made to the spectral energy distributions for these PPNs to determine properties of the detached circumstellar envelopes. The 21 μm feature has been seen in all Galactic carbon-rich PPNs observed, and thus its carrier appears to be a common component of the outflow around these objects.

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The magnetic field toward the young planetary nebula K 3-35

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K 3-35 is a planetary nebula (PN) where water maser emission has been detected, suggesting that it departed from the proto-PNe phase only some decades ago.Interferometric VLA observations of the OH 18 cm transitions in K 3-35 are presented. OH maser emission is detected in all four ground state lines (1612, 1665, 1667, and 1720 MHz). All the masers appear blueshifted with respect to the systemic velocity of the nebula and they have different spatial and kinematic distributions.The OH 1665 and 1720 MHz masers appear spatially coincident with the core of the nebula, while the OH 1612 and 1667 MHz ones exhibit a more extended distribution. We suggest that the 1665 and 1720 masers arise from a region close to the central star, possibly in a torus, while the 1612 and 1667 lines originate mainly from the extended northern lobe of the outflow.It is worth noting that the location and velocity of the OH 1720 MHz maser emission are very similar to those of the water masers (coinciding within $0.1''$ and ~ 2 km s^{-1}, respectively). We suggest that the pumping mechanism in the water masers could be produced by the same shock that is exciting the OH 1720 MHz transition.A high degree of circular polarization ($> 50\%$) was found to be present in some features of the 1612, 1665, and 1720 MHz emission. For the 1665 MHz transition at $\sim +18$ km s^{-1} the emission with left and right circular polarizations (LCP and RCP) coincide spatially within a region of $\sim 0.03''$ in diameter.Assuming that these RCP and LCP 1665 features come from a Zeeman pair, we estimate a magnetic field of ~ 0.9 mG within 150 AU from the 1.3 cm continuum peak. This value is in agreement with a solar-type magnetic field associated with evolved stars.

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C/O white dwarfs of very low mass: 0.33–0.5 $M_\odot$

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The standard lower limit for the mass of white dwarfs (WDs) with a C/O core is roughly 0.5 $M_\odot$. In the present work we investigated the possibility to form C/O WDs with mass as low as 0.33 $M_\odot$. Both the pre-WD and the cooling evolution of such nonstandard models will be described.

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K-Isomers in odd-odd nuclei on the s-process path: ^{176}Lu, ^{180}Ta, and ^{186}Re

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The thermal coupling between low-K and high-K states via so-called intermediate states (IS) in a stellar photon bath is analyzed. The transition rates depend linearly on the integrated cross sections of IS and exponentially on temperature. These transitions may affect the effective half-life of nuclei under stellar conditions dramatically. Three examples are studied in detail: ^{176}Lu, ^{180}Ta, and ^{186}Re. ^{176}Lu acts as a thermometer for the s-process; however, there are discrepancies for the integrated cross section of the lowest IS at 839 keV. ^{180}Ta is thermalized under s-process conditions within hours and may be interpreted as a "mixometer" for the fast convective mixing in AGB stars. In the p(γ)-process and ν-process ^{180}Ta is produced in thermal equilibrium leading to survival of about one third of the synthesized ^{180}Ta in the 9^- isomeric state. The (8^+) isomer in ^{186}Re does not have significant influence on the s-process branching at ^{186}Re.

Poster contribution, published in POS (NIC X) 081, Nuclei in the Cosmos X, Mackinac Island, 2008
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Dynamo-generated magnetic fields in fast rotating single giants

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Red giants offer a good opportunity to study the interplay of magnetic fields and stellar evolution. Using the spectropolarimeter NARVAL of the Telescope Bernard Lyot (TBL), Pic du Midi, France and the LSD technique, we began a survey of magnetic fields in single G-K-M giants. Early results include 6 MF-detections with fast rotating giants, and for the first time a magnetic field was detected directly in an evolved M-giant: EK Boo. Our results could be

explained in the terms of α–ω dynamo operating in these giants.

Poster contribution, published in IAUS259: "Cosmic Magnetic Fields"
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Central Stars of Planetary Nebulae in SDSS and IPHAS

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Space densities and birthrates of Planetary Nebulae (PNe) are highly uncertain. A large range of formation rates has been derived by different studies, which has led to contradicting ideas for the final evolutionary phases of low and intermediate mass stars. We started a project to deduce a birthrate using a sample of PNe within 2 kpc. The central stars will be identified in the PNe fields by their photometric colours and then used to establish improved distance estimates. To facilitate this we have created grids of photometric colours which are used to constrain stellar parameters. Our study has concentrated on PNe in SDSS and the INT Photometric Hα Survey (IPHAS) so far. IPHAS is a nearly complete northern galactic plane survey in Hα, r$'$ and i$'$ bands. Many previously unknown PNe have been discovered with IPHAS. We investigate implications of a more complete local sample on PN birthrate estimates.

Poster contribution, published in 16^{th} **European WD Workshop, Barcelona**

Available from arXiv:0901.2324

A Progress Report on the Carbon Dominated Atmosphere White Dwarfs

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Recently, Dufour et al. (2007) reported the unexpected discovery that a few white dwarfs found in the Sloan Digital Sky Survey had an atmosphere dominated by carbon with little or no trace of hydrogen and helium. Here we present a progress report on these new objects based on new high signal-to-noise follow-up spectroscopic observations obtained at the 6.5m MMT telescope on Mount Hopkins, Arizona.

Oral contribution, published in 16^{th} **European White Dwarf Workshop, Journal of Physics Conference Proceedings**
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Intracluster Planetary Nebulae in the Hydra I cluster

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Using the Multislit Imaging Spectroscopy (MSIS) technique at the FORS2 spectrograph on VLT-UT1, we have identified 60 Intracluster Planetary Nebula (ICPN) candidates associated with the Intracluster Light (ICL) in the central region of the Hydra I cluster. Hydra I is a medium compact, relatively near ($\sim$ 50 Mpc), rich cluster in the southern hemisphere. Here we describe the criteria used to select emission sources and present the evidence for these PN

candidates to be associated with the ICL in the Hydra I cluster. We also show, using the luminosity-specific planetary nebulae number, the alpha parameter, that the expected number of PNs associated with the stellar population of the central cD galaxy NGC 3311 in the cluster is close to the number of PNs detected.

Poster contribution, published in "Galactic and Stellar Dynamics 2008" conference, Ed. C.M. Boily. Published in AN, year: 2008, vol: 329, Issue: 9–10, pages: 1057–1060 (refereed proceedings)
Available from arXiv:0901.1197

Chemical Yields from Supernovae and Hypernovae

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We review the final stages of stellar evolution, supernova properties, and chemical yields as a function of the progenitor's mass M. (1) 8–10 $M_\odot$ stars are super-AGB stars when the O+Ne+Mg core collapses due to electron capture. These AGB-supernovae may constitute an SN 2008S-like sub-class of Type IIn supernovae. These stars produce little α-elements and Fe-peak elements, but are important sources of Zn and light p-nuclei. (2) 10–90 $M_\odot$ stars undergo Fe-core collapse. Nucleosynthesis in aspherical explosions is important, as it can well reproduce the abundance patterns observed in extremely metal-poor stars. (3) 90–140 $M_\odot$ stars undergo pulsational nuclear instabilities at various nuclear burning stages, including O and Si-burning. (4) 140–300 $M_\odot$ stars become pair-instability supernovae, if the mass loss is small enough. (5) Very massive stars with $M \gtrsim 300$ $M_\odot$ undergo core-collapse to form intermediate mass black holes.

Oral contribution, published in IAU Symposium No. 254: "The Galaxy Disk in Cosmological Context" (2008), eds. J. Andersen, J. Bland-Hawthorn & B. Nordstrom (Cambridge University Press)
Available from arXiv:0901.4536

Review Paper

Detection methods of binary stars with low- and intermediate-mass components

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This chapter reviews methods which can be used to detect binaries involving low- and intermediate-mass stars, with special emphasis on evolved systems. Besides the traditional methods involving radial-velocity or photometric monitoring, the paper discusses as well less known methods involving astrometry or maser (non-)detection. An extensive list of internet resources (mostly catalogues/databases of orbits and individual measurements) for the study of binary stars is provided at the end of the paper.

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PhD applicants must have achieved (or be expecting to achieve within June 2009) a degree in physics, astrophysics or a related subject.

HOW TO APPLY:
Click here (OPEN from January 12 to 26): http://web.micinn.es/planidi/fpi (convocatoria 2009)

DOCUMENTATION NEEDED:
1. Your official academic record, accompanied by an explanation of the grading system, and translated to spanish.
2. Passport copy
3. CV

Interested candidates, please contact with:
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See also http://web.micinn.es/contenido.asp?menu1=1&menu2=&menu3=&dir=03_Plan_IDI/00-LIAs/00@LIARRHH/00-Formacion/00@FPI/001Con09

NAM/JENAM symposium 'The life cycle of dust'

The combined NAM/JENAM meeting, to be held 20–23 April 2009 in Hatfield, UK, will include a symposium on the life cycle of dust. AGB stars play an important part in this, being the dominant source of dust in the local Universe and a potentially important source in the early Universe. We welcome contributions from the AGB community.

Dust plays an important role in the evolution of the Universe. It is formed from the winds and ejecta of stars and supernovae and has been a major component of the interstellar medium from the very earliest galaxies, through the evolution of the proto-solar nebula to the present day galactic environment. Interplanetary, interstellar and extragalactic dust are traditionally studied by different disciplines using very different tools, ranging from laboratory analyses of extra-terrestrial samples, space craft collection/in-situ analysis, astronomical spectroscopy to sub-mm photometry and theoretical modelling. There is usually little overlap between knowledge gained by the different disciplines and this symposium will focus on dust in all of its guises: interplanetary, circumstellar, interstellar, intra-galactic and early-Universe dust. The goal is to link the different disciplines in order to cross-fertilize areas and build new understanding of the life cycle of dust. Symposium themes will include: dust origins and evolution; dust and galaxy evolution; dust compositions: silicates, carbon/organics, isotopic content; Solar System dust; circumstellar and interstellar dust; and dust in the early Universe.

Keynote review talks will be given by Xander Tielens, on dust formation, and Ernst Zinner, on the laboratory analysis of interstellar grains.

Registration will open shortly and the deadline for submission of abstracts is likely to be early March.

See also http://www.jenam2009.eu