THE AGB NEWSLETTER

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Editors: Jacco van Loon and Albert Zijlstra

Editorial

Dear Colleagues,

It is our pleasure to present you the 151st issue of the AGB Newsletter. Enjoy!

Just one reaction was received, in response to the question about the most important challenges for the next decade:

Mass-loss and its dependence on other stellar parameters such as luminosity, temperature, and metallicity, is and remains a very important issue. In order to construct evolutionary models with more predictive power, we need to understand mass-loss better than we do now.

Second, the question of whether or not AGB stars are the polluters of the first generation of Globular Clusters is important. Even if it turns out that they aren't, the effort we make and the things we thereby learn about AGB stars will lead to great progress.

Finally, although this is maybe a bit biased towards my own interests, I think the question of what is the minimum initial mass required for a star in order to experience third dredge-up, hence to contribute to the enrichment of the ISM with heavy elements, is important. It seems at the moment that it could be anything between 1 and 2 $M_{\odot}$, but the number of stars in this mass range is quite large!

The next issue is planned to be distributed on the 1st of March 2010.

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

Astro-seismology is a feasible tool to unravel the interiors of AGB stars

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

Age distribution of the central stars of galactic disk planetary nebulae

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The determination of ages of central stars of planetary nebulae (CSPN) is a complex problem, and there is presently no single method that can be generally applied. We have developed several methods to estimate the ages of CSPN, based both on the observed nebular properties and in some properties of the stars themselves.Our aim is to estimate the ages and the age distribution of CSPN and to compare the derived results with mass and age determinations of CSPN and white dwarfs based on empirical determinations of these quantities. We discuss several methods to derive the age distribution of CSPN, namely, (i) the use of an age–metallicity relation that also depends on the galactocentric distance, (ii) the use of an age–metallicity relation obtained for the galactic disk, and (iii) the determination of ages from the central star masses obtained from the observed nitrogen abundances. We consider a sample of planetary nebulae in the galactic disk, most of which ($\sim$ 69%) are located in the solar neighbourhood, within 3 kpc from the Sun. We estimate the age distribution of CSPN with average uncertainties of 1–2 Gyr, and compare our results with the expected distribution based both on the observed mass distribution of white dwarfs and on the age distribution derived from available mass distributions of CSPN. We conclude most CSPN in the galactic disk have ages under 6 Gyr, and that the age distribution is peaked around 2–4 Gyr.

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Available from arXiv:0912.4124
and from http://www.astro.iag.usp.br/∼maciel

Comprehensive photometric histories of all known Galactic recurrent novae

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I collect virtually all photometry of the ten known Galactic recurrent novae (RNe) and their 37 known eruptions. This consists of my modern measures of nearly all archival plates (providing the only data for half of 37 known eruptions), my own 10,000 CCD magnitudes from 1987 to present (providing virtually all of the magnitudes in quiescence for seven RNe), over 140,000 visual magnitude estimates recorded by amateur astronomers (who discovered half the known eruptions), and the small scattering of magnitudes from all the literature. From this, I produce various uniform products; (1) BVRIJHK comparison star magnitudes and BV comparison star sequences to cover the entire range of eruption, (2) complete light curves for all eruptions, (3) best fit B and V light curve templates, (4) orbital periods for all-but-one RN, (5) exhaustive searches for all missed eruptions, (6) measured discovery effiencies since 1890, (7) true recurrence time scales, (8) predicted next eruption dates, (9) variations on time scales of minutes, hours, days, months, years, decades, and century, (10) uniform distances and extinctions to all RNe, (11) BV colors at peak and UBVRIJHK colors at minimum all with extinction corrections, and (12) the spectral energy distributions over UBVRIJHK. Highlights of this work include the discoveries of one new RN, six previously-undiscovered eruptions, and the discovery of the orbital periods for half the RNe. The goal of this work is to provide uniform demographics for answering questions like the 'What is the death rate of RNe in our galaxy?' and 'Are the white dwarfs gaining or losing mass over each eruption cycle?'. An important use of this work is for the question of whether RNe can be the progenitors of Type Ia supernovae.

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Molecular astronomy of cool stars and sub-stellar objects

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The optical and infrared spectra of a wide variety of "cool" astronomical objects including the Sun, sunspots, K-, M- and S-type stars, carbon stars, brown dwarfs and extrasolar planets are reviewed. The review provides the necessary astronomical background for chemical physicists to understand and appreciate the unique molecular environments found in astronomy. The calculation of molecular opacities needed to simulate the observed spectral energy distributions is discussed.

Published in International Reviews in Physical Chemistry, 28, 681–709 (2009)
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The CH fraction of carbon stars at high Galactic latitudes

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CH stars form a distinct class of objects with characteristic properties like iron deficiency, enrichment of carbon and overabundance in heavy elements. These properties can provide strong observational constraints for theoretical computation of nucleosynthesis at low-metallicity. An important question is the relative surface density of CH stars which can provide valuable inputs to our understanding on the role of low to intermediate-mass stars in the early Galactic chemical evolution. Spectroscopic characterization provides an effective way of identifying CH stars. The present analysis is aimed at a quantitative assessment of the fraction of CH stars in a sample of stars using a set of spectral classification criteria. The sample consists of ninety two objects selected from a collection of candidate faint high latitude carbon stars from the Hamburg/ESO survey. Medium resolution $(\lambda/\delta\lambda) \sim 1300$) spectra for these objects were obtained using OMR at VBO, Kavalur and HFOSC at HCT, IAO, Hanle, during 2007–2009 spanning a wavelength range 3800–6800 Å. Spectral analysis shows 36 of the 92 objects to be potential CH stars; combined with our earlier studies (Goswami 2005, Goswami et al. 2007) this implies $\sim 37\%$ (of 243) objects as the CH fraction. We present spectral descriptions of the newly identified CH star candidates. Estimated effective temperatures, $^{12}C/^{13}C$ isotopic ratios and their locations on the two colour J–H vs. H–K plot are used to support their identification.

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The Optical Gravitational Lensing Experiment. The OGLE-III Catalog of Variable Stars. V. R Coronae Borealis Stars in the Large Magellanic Cloud

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The fifth part of the OGLE-III Catalog of Variable Stars presents 23 R CrB (RCB) stars in the Large Magellanic Cloud (LMC). 17 of these objects have been spectroscopically confirmed by previous studies, while 6 stars are new candidates for RCB variables. We publish the *VI* multi-epoch OGLE photometry for all objects.
We use the sample of carbon-rich long-period variables released in the previous part of this catalog to select objects with severe drops in luminosity, i.e. with the DY Per-like light curves. DY Per stars are often related to R CrB variables. We detect at least 600 candidates for DY Per stars, mostly among dust enshrouded giants. We notice that our candidate DY Per stars form a continuity with other carbon-rich long-period variables, so it seems that DY Per

stars do not constitute a separate group of variable stars.

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and from http://acta.astrouw.edu.pl/Vol59/n4/pdf/pap_59_4_1.pdf

Identifying bright stars in crowded environments using velocity dispersion measurements, and an application to the centre of M 32

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The identification of individual stars in crowded environments using photometric information alone is confounded by source confusion. However, with the addition of spectroscopic information it is possible to distinguish between blends and areas where the light is dominated by a single star using the widths of absorption features. We describe a procedure for identifying locations in kinematically hot environments where the light is dominated by a single star, and apply this method to spectra with$0.1''$ angular resolution covering the 2.1–2.3 μm interval in the central regions of M 32. Targets for detailed investigation are selected as areas of localized brightness enhancement. Three locations where at least 60% of the K-band light comes from a single bright star, and another with light that is dominated by two stars with very different velocities, are identified. The dominant stars are evolving near the tip of the asymptotic giant branch (AGB), and have M5 III spectral type. The lack of a dispersion in spectral-type suggests that the upper AGB within the central arcsec of M 32 has a dispersion in J–K of only a few hundreths of a magnitude, in agreement with what is seen at larger radii. One star has weaker atomic absorption lines than the others, such that [M/H] is 0.2 dex lower. Such a difference in metallicity is consistent with the metallicity dispersion inferred from the width of the AGB in M 32. The use of line width to distinguish between blends involving many relatively faint stars, none of which dominate the light output, and areas that are dominated by a single intrinsically bright star could be extended to crowded environments in other nearby galaxies.

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Second generation planets

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Currently, a few hundreds of extra-Solar planetary systems have been found; most of them around main sequence stars, with a few tens found in wide binary systems, and few of those in evolved old systems. Typically, such (first generation) planets are thought to form in a protoplanetary disk left over after the stellar formation of the central star in a protostellar disk. Here we suggest an additional planetary formation route which can occur in old evolved binary systems. In close enough binary systems (separations of up to ~ 200 AU) stellar evolution of one of the binary components could lead to its expansion and the formation of a symbiotic star. In such a system mass is transferred from the expanding star to its companion, forming an accretion disk around it. Such a disk could provide the necessary environment for the formation of a new, second generation of planets in both circumstellar or circumbinary configurations. Pre-existing first generation planets surviving the post-MS evolution of such systems may serve as seeds for, and/or interact with, the second generation planets, possibly forming atypical planetary systems. Such formation route could also lead to planet formation around compact objects, which differs from currently suggested mechanisms. Second generation planetary systems should be typically found in white dwarf binary systems, and may show various observational signatures. Most notably, second generation planets could form in environment which are inaccessible, or less favorable, for first generation planets. The orbital phase space available for the second generation planets could be forbidden (in terms of the system stability) to first generation planets in the pre-evolved progenitor

binaries. In additions planets could form even in metal poor environments such as globular clusters. Observations of exo-planets in such forbidden or unfavorable regions could possibly serve to uniquely identify their second generation character. Finally, we point out a few observed exo-planetary systems in evolved systems which are consistent with being second generation systems, including Gl 86, HD 27442, the globular cluster planet PSR B1620–26 and all of the currently observed circumbinary planet candidates. In particular, a second generation origin for these planets could naturally explain their unique configurations.

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New candidate Planetary Nebulae in the IPHAS survey: the case of PNe with ISM interaction

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We present the results of the search for candidate Planetary Nebulae interacting with the interstellar medium (PN-ISM) in the framework of the INT Photometric Hα Survey (IPHAS) and located in the right ascension range 18^{h}–20^{h}. The detection capability of this new Northern survey, in terms of depth and imaging resolution, has allowed us to overcome the detection problem generally associated to the low surface brightness inherent to PNe-ISM. We discuss the detection of 21 IPHAS PN-ISM candidates. Thus, different stages of interaction were observed, implying various morphologies i.e. from the unaffected to totally disrupted shapes. The majority of the sources belong to the so-called WZO2 stage which main characteristic is a brightening of the nebula's shell in the direction of motion. The new findings are encouraging as they would be a first step into the reduction of the scarcity of observational data and they would provide new insights into the physical processes occurring in the rather evolved PNe.

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AKARI near- to mid-infrared imaging and spectroscopic observations of the Small Magellanic Cloud. I. Bright point source list

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We carried out a near- to mid-infrared imaging and spectroscopic observations of the patchy areas in the Small Magellanic Cloud using the Infrared Camera on board AKARI. Two 100 arcmin^2 areas were imaged in 3.2, 4.1, 7, 11, 15, and 24 μm and also spectroscopically observed in the wavelength range continuously from 2.5 to 13.4 μm. The spectral resolving power ($\lambda/\Delta\lambda$) is about 20, 50, and 50 at 3.5, 6.6 and 10.6 μm, respectively. Other than the two 100 arcmin^2 areas, some patchy areas were imaged and/or spectroscopically observed as well. In this paper, we overview

the observations and present a list of near- to mid-infrared photometric results, which lists $\sim 12,000$ near-infrared and $\sim 1,800$ mid-infrared bright point sources detected in the observed areas. The 10-σ limits are 16.50, 16.12, 13.28, 11.26, 9.62, and 8.76 in Vega magnitudes at 3.2, 4.1, 7, 11, 15, and 24 μm bands, respectively.

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First overtone CO bands in the giant component of RS Ophiuchi: the ^{12}C/^{13}C ratio in 2008

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We present an analysis of a high resolution ($R = 40\,000$) infrared spectrum of the RS Oph secondary around the first overtone CO bands, obtained in 2008 May onthe Gemini South 8 m. The ^{12}CO and ^{13}CO bands are well-resolved, and we compute synthetic spectra to determine the ^{12}C/^{13}C ratio.We find ^{12}C/^{13}C $= 16 \pm 3$, consistent with the interpretation of the secondary as red giant which has evolved beyond the first drege-up phase of evolution.

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870 μm observations of evolved stars with LABOCA

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During their evolution, Asymptotic Giant Branch (AGB) stars experience a high mass-loss which leads to the formation of a Circumstellar Envelope (CSE) of dust and gas. The mass-loss process is the most important phenomenon during this evolutionary stage. In order to understand it, it is important to study the physical parameters of the CSE. The emission of the CSE in the (sub)millimetre range is dominated by the dust continuum. This means that (sub)millimetre observations are a key tool in tracing the dust and improving our knowledge of the mass-loss process. In this paper we analyse new sub-millimetre observations of 9 evolved stars in order to constrain the CSE physical parameters. The data were taken by the new APEX bolometer LABoCa.
The fluxes at 870 μm are derived and the extended emission is investigated. We compute the spectral energy distribution (SEDs) using a 1D radiative transfer code, DUSTY which we compared to literature data. Grain properties are calculated using both spherical grains distribution and a Continuous Distribution of Ellipsoids (CDE) and a comparison between the two is drawn. Synthetic surface brightness maps have been derived from the modelling and were compared to the LABoCa brightness maps.
We detected the presence of extended emission around four stars. Physical parameters of the circumstellar envelope are derived from SED modelling, such as the dust chemical composition, the dust condensation temperature and the total mass of the envelope. It proves difficult however to fit the SED and the intensity profile simultaneously.

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PG 1258+593 and its common proper motion magnetic white dwarf counterpart

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We identify SDSS J130033.48+590407.0 as a common proper motion companion to the well-studied DA white dwarf PG 1258+593 (GD322). The system lies at a distance of 68 ± 3 pc, where the angular separation of 16.1 ± 0.1 arcsec corresponds to a minimum binary separation of 1091 ± 7 AU. SDSS J1300+5904 is a cool ($T_{\rm eff} = 6300 \pm 300$ K) magnetic white dwarf ($B \sim 6$ MG). PG 1258+593 is a hydrogen-rich (DA) white dwarf with $T_{\rm eff} = 14790 \pm 77$ K and $\log(g) = 7.87 \pm 0.02$. Using the white dwarf mass–radius relation implies the masses of SDSS J1300+5904 and PG 1258+593 are 0.54 ± 0.06 $M_\odot$ and 0.54 ± 0.01 $M_\odot$, respectively, and therefore a cooling age difference of 1.67 ± 0.05 Gyr. Adopting main-sequence life times from stellar models, we derive an upper limit of 2.2 $M_\odot$ for the mass of the progenitor of PG 1258+593. A plausible range of initial masses is 1.4–1.8 $M_\odot$ for PG 1258+593 and 2–3 $M_\odot$ for SDSS J1300+5904. Our analysis shows that white dwarf common proper motion binaries can potentially constrain the white dwarf initial–final mass relation and the formation mechanism for magnetic white dwarfs. The magnetic field of SDSS J1300+5904 is consistent with an Ap progenitor star. A common envelope origin of the system cannot be excluded, but requires a triple system as progenitor.

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Evolution of massive AGB stars : III the thermally pulsing super-AGB phase

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We present the first simulations of the full evolution of super-AGB stars through the entire thermally pulsing AGB phase. We analyse their structural and evolutionary properties and determine the first SAGB yields. Stellar models of various initial masses and metallicities were computed using standard physical assumptions which prevents the third dredge-up. A postprocessing nucleosynthesis code was used to compute the SAGB yields, to quantify the effect of the third dredge-up (3DUP) and to assess the uncertainties associated with the treatment of convection. Owing to their massive oxygen–neon core, SAGB stars suffer weak thermal pulses, have very short interpulse periods and develop very high temperatures at the base of their convective envelope (up to $1.4\,10^8$ K), leading to very efficient hot bottom burning. SAGB stars are consequently heavy manufacturers of ^{4}He, ^{13}C, and ^{14}N. They are also able to inject significant amounts of ^{7}Li, ^{17}O, ^{25}Mg, and ^{26,27}Al in the interstellar medium. The 3DUP mainly affects the CNO yields, especially in the lower metallicity models. Our post-processing simulations also indicate that changes in the temperature at the base of the convective envelope, which would result from a change in the efficiency of convective energy transport, have a dramatic impact on the yields and represent another major source of uncertainty.

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Differential proper-motion study of the circumstellar dust shell of the enigmatic object, HD 179821

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HD 179821 is an enigmatic evolved star that possesses characteristics of both a post-asymptotic giant branch star and a yellow hyper-giant, and there has been no evidence that unambiguously defines its nature. These two hypotheses are products of an indeterminate distance, presumed to be 1 kpc or 6 kpc. We have obtained the two-epoch Hubble Space Telescope WFPC2 data of its circumstellar shell, which shows multiple concentric arcs extending out to $\approx 8''$. We have performed differential proper-motion measurements on distinct structures within the circumstellar shell of this mysterious star in hopes of determining the distance to the object, and thereby distinguishing the nature of this enigmatic stellar source. Upon investigation, rather than azimuthal radially symmetric expansion, we discovered a bulk motion of the circumstellar shell of $(2.41 \pm 0.43, 2.97 \pm 0.32)$ mas yr^{-1}. This corresponded to a translational ISM flow of $(1.28 \pm 0.95, 7.27 \pm 0.75)$ mas yr^{-1} local to the star. This finding implies that the distance to HD 179821 should be rather small in order for its circumstellar shell to preserve its highly intact spherical structure in the presence of the distorting ISM flow, therefore favoring the proposition that HD 179821 is a post-AGB object.

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Discovery of the first wide L dwarf + giant binary system and eight other ultra-cool dwarfs in wide binaries

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We identify 806 ultra-cool dwarfs from their SDSS riz photometry (of which 34 are newly discovered L dwarfs) and obtain proper motions through cross matching with UKIDSS and 2MASS. Proper motion and distance constraints show that nine of our ultra-cool dwarfs are members of widely separated binary systems; SDSS 0101 (K5V+M9.5V), SDSS 0207 (M1.5V+L3V), SDSS 0832 (K3III+L3.5V), SDSS 0858 (M4V+L0V), SDSS 0953 (M4V+M9.5V), SDSS 0956 (M2V+M9V), SDSS 1304 (M4.5V+L0V), SDSS 1631 (M5.5V+M8V), SDSS 1638 (M4V+L0V). One of these (SDSS 0832) is shown to be a companion to the bright K3 giant η Cancri. Such primaries can provide age and metallicity constraints for any companion objects, yielding excellent benchmark objects. η Cancri AB is the first wide ultra-cool dwarf + giant binary system identified. We present new observations and analysis that constrain the metallicity of η Cancri A to be near solar, and use recent evolutionary models to constrain the age of the giant to be 2.2–6.1 Gyr. If η Cancri B is a single object, we estimate its physical attributes to be; M = 63–82 $M_{\rm Jup}$, $T_{\rm eff} = 1800 \pm 150$ K, $\log g$ = 5.3–5.5, [M/H]= 0.0 ± 0.1. Its colours are non typical when compared to other ultra-cool dwarfs, and we also assess the possibility that η Cancri B is itself an unresolved binary, showing that the combined light of an L4 + T4 system could provide a reasonable explanation for its colours.

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A precessing jet in the CH Cyg symbiotic system

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Jets have been detected in only a few symbiotic binaries to date, and CH Cyg is one of them. In 2001, a non-relativistic jet was detected in CH Cyg for the first time in X-rays. We carried out coordinated Chandra, HST, and VLA observations in 2008 to study the propagation of this jet and its interaction with the circumbinary medium. We detected the jet with Chandra and HST and determined that the apex has expanded to the South from ~ 300 AU to ~ 1400 AU, with the shock front propagating with velocity < 100 km s^{-1}. The shock front has significantly slowed down since 2001. Unexpectedly, we also discovered a powerful jet in the NE–SW direction, in the X-ray, optical and radio. This jet has a multi-component structure, including an inner jet and a counter-jet at ~ 170 AU, and a SW component ending in several clumps extending out to ~ 750 AU. The structure of the jet and the curvature of the outer portion of the SW jet suggest an episodically powered precessing jet, or a continuous precessing jet with occasional mass ejections or pulses. We carried out detailed spatial mapping of the X-ray emission and correlation with the optical and radio emission. X-ray spectra were extracted of the central source, inner NE counter jet, and the brightest clump at a distance of ~ 500 AU from the central source. We discuss the initial results of our analysis, including the multi-component spectral fitting of the jet-components and of the central source.

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Dusty winds — II. Observational implications

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We compare observations of AGB stars and predictions of the Elitzur & Ivezić (2001) steady-state radiatively driven dusty wind model. The model results are described by a set of similarity functions of a single independent variable, and imply general scaling relations among the system parameters. We find that the model properly reproduces various correlations among the observed quantities and demonstrate that dust drift through the gas has a major impact on the structure of most winds. From data for nearby oxygen-rich and carbon-rich mass-losing stars we find that (1) the dispersion in grain properties within each group is rather small; (2) both the dust cross-section per gas particle and the dust-to-gas mass ratio are similar for the two samples even though the stellar atmospheres and grain properties are very different; (3) the dust abundance in both outflows is significantly below the Galactic average, indicating that most of the Galactic dust is not stardust — contrary to popular belief, but in support of Draine (2009). Our model results can be easily applied to recent massive data sets, such as the Spitzer SAGE survey of the Large Magellanic Cloud, and incorporated in galaxy evolution models.

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Planetary nebulae in M 33: probes of AGB nucleosynthesis and ISM abundances

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We have obtained deep optical spectrophotometry of 16 planetary nebulae in M 33, mostly located in the central

two kpc of the galaxy, with the Subaru and Keck telescopes. We have derived electron temperatures and chemical abundances from the detection of the [O III]4363 line for the whole sample. We have found one object with an extreme nitrogen abundance, $12 + \log(N/H) = 9.20$, accompanied by a large helium content. After combining our data with those available in the literature for PNe and H II regions, we have examined the behavior of nitrogen, neon, oxygen and argon in relation to each other, and as a function of galactocentric distance. We confirm the good correlation between Ne/H and O/H for PNe in M 33. Ar/H is also found to correlate with O/H. This strengthens the idea that at the metallicity of the bright PNe analyzed in M 33, which is similar to that found in the LMC, these elements have not been significantly modified during the dredge-up processes that take place during the AGB phase of their progenitor stars. We find no significant oxygen abundance offset between PNe and H II regions at any given galactocentric distance, despite the fact that these objects represent different age groups in the evolution of the galaxy. Combining the results from PNe and H II regions, we obtain a representative slope of the ISM α-element (O, Ar, Ne) abundance gradient in M 33 of -0.025 ± 0.006 dex kpc^{-1}. Both PNe and H II regions display a large abundance dispersion at any given distance from the galactic center. We find that the N/O ratio in PNe is enhanced, relative to the H II regions, by approximately 0.8 dex.

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Can solid body destruction explain abundance discrepancies in planetary nebulae?

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In planetary nebulae, abundances of oxygen and other heavy elements derived from optical recombination lines are systematically higher than those derived from collisionally excited lines. We investigate the hypothesis that the destruction of solid bodies may produce pockets of cool, high-metallicity gas that could explain these abundance discrepancies. Under the assumption of maximally efficient radiative ablation, we derive two fundamental constraints that the solid bodies must satisfy in order that their evaporation during the planetary nebula phase should generate a high enough gas phase metallicity. A local constraint implies that the bodies must be larger than tens of meters, while a global constraint implies that the total mass of the solid body reservoir must exceed a few hundredths of a solar mass. This mass greatly exceeds the mass of any population of comets or large debris particles expected to be found orbiting evolved low- to intermediate-mass stars. We therefore conclude that contemporaneous solid body destruction cannot explain the observed abundance discrepancies in planetary nebulae. However, similar arguments applied to the sublimation of solid bodies during the preceding asymptotic giant branch (AGB) phase do not lead to such a clear-cut conclusion. In this case, the required reservoir of volatile solids is only one ten-thousandth of a solar mass, which is comparable to the most massive debris disks observed around solar-type stars, implying that this mechanism may contribute to abundance discrepancies in at least some planetary nebulae, so long as mixing of the high metallicity gas is inefficient.

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Peculiarities and variations in the optical spectrum of the post-AGB star V448 Lac = IRAS 22223+4327.

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Multi-epoch observations with high spectral resolution acquired in 1998–2008 are used to study the temporal behavior of the spectral line profiles and velocity field in the atmosphere and circumstellar envelope of the post-AGB star V448 Lac. Asymmetry of the profiles of the strongest absorption lines with low-level excitation potentials $f\chi_{\rm low} < 1$ eV and time variations of these profiles have been detected, most prominently the profiles of the resonance lines of Ba II, Y II, La II, Si II. The peculiarity of these profiles can be explained using a superposition of stellar absorption line and shell emission lines. Emission in the (0; 1) 5635 Å Swan band of the C_2 molecule has been detected in the spectrum of V448 Lac for the first time. The core of the Hα line displays radial velocity variations with an amplitude of $\Delta V_{\rm r} \approx 8$ km s^{-1}. Radial velocity variations displayed by weak metallic lines with lower amplitudes, $\Delta V_{\rm r} \approx 1$–2 km s^{-1}, may be due to atmospheric pulsations. Differential line shifts, $\Delta V_{\rm r} = 0 \div 8$ km s^{-1}, have been detected on various dates. The position of the molecular spectrum is stationary in time, indicating a constant expansion velocity of the circumstellar shell, $V_{\rm exp} = 15.2$ km s^{-1}, as derived from the C_2 and Na I lines.

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Disk evaporation in a planetary nebula

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We study the Galactic bulge planetary nebula M 2-29 (for which a 3-year eclipse event of the central star has been attributed to a dust disk) using HST imaging and VLT spectroscopy, both long-slit and integral field. The central PN cavity of M 2-29 is filled with a decreasing, slow wind. An inner high density core is detected, with radius less than 250 AU, interpreted as a rotating gas/dust disk with a bipolar disk wind. The evaporating disk is argued to be the source of the slow wind. The central star is a source of a very fast wind (1000 km s^{-1}). An outer, partial ring is seen in the equatorial plane, expanding at 12 km s^{-1}. The azimuthal asymmetry is attributed to mass-loss modulation by an eccentric binary. M 2-29 presents a crucial point in disk evolution, where ionization causes the gas to be lost, leaving a low-mass dust disk behind.

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Conference Papers

Element abundance determination in hot evolved stars

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The hydrogen-deficiency in extremely hot post-AGB stars of spectral class PG 1159 is probably caused by a (very) late helium-shell flash or a AGB final thermal pulse that consumes the hydrogen envelope, exposing the usually-hidden intershell region. Thus, the photospheric element abundances of these stars allow us to draw conclusions about details of nuclear burning and mixing processes in the precursor AGB stars. We compare predicted element abundances to those determined by quantitative spectral analyses performed with advanced non-LTE model atmospheres. A good qualitative and quantitative agreement is found for many species (He, C, N, O, Ne, F, Si, Ar) but discrepancies for others (P, S, Fe) point at shortcomings in stellar evolution models for AGB stars. Almost all of the chemical trace

elements in these hot stars can only be identified in the UV spectral range. The *Far Ultraviolet Spectroscopic Explorer* and the *Hubble Space Telescope* played a crucial role for this research.

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Some properties of the kinetic energy flux and dissipation in turbulent stellar convection zones

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We investigate simulated turbulent flow within thermally driven stellar convection zones. Different driving sources are studied, including cooling at the top of the convectively unstable region, as occurs in surface convection zones; and heating at the base by nuclear burning. The transport of enthalpy and kinetic energy, and the distribution of turbulent kinetic energy dissipation are studied. We emphasize the importance of global constraints on shaping the quasi-steady flow characteristics, and present an analysis of turbulent convection which is posed as a boundary value problem that can be easily incorporated into standard stellar evolution codes for deep, efficient convection. Direct comparison is made between the theoretical analysis and the simulated flow and very good agreement is found. Some common assumptions traditionally used to treat quasi-steady turbulent flow in stellar models are briefly discussed. The importance and proper treatment of convective boundaries are indicated.

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Red giants observed with CoRoT

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Observations of red (G–K)-giant stars with the CoRoT satellite provide unprecedented information on the stochastically excited oscillations in these stars. The long time series of nearly uninterrupted high-cadence and high-precision photometry revealed the presence of non-radial modes with long lifetimes, which opens the possibility to perform asteroseismology on these stars. Also, the large number of red giants, for which solar-like oscillations are now observed, allows for a more statistical investigation of the characteristics of solar-like oscillations in red giants.

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Review Papers

Galactic evolution of D, ^{3}He and ^{4}He

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The uncertainties which still plague our understanding of the evolution of the light nuclides D, ^{3}He and ^{4}He in the Galaxy are described. Measurements of the local abundance of deuterium range over a factor of 3. The observed dispersion can be reconciled with the predictions on deuterium evolution from standard Galactic chemical evolution models, if the true local abundance of deuterium proves to be high, but not too high, and lower observed values are due to depletion onto dust grains. The nearly constancy of the ^{3}He abundance with both time and position within the Galaxy implies a negligible production of this element in stars, at variance with predictions from standard stellar models which, however, do agree with the (few) measurements of ^{3}He in planetary nebulae. Thermohaline mixing, inhibited by magnetic fields in a small fraction of low-mass stars, could in principle explain the complexity of the overall scenario. However, complete grids of stellar yields taking this mechanism into account are not available for use in chemical evolution models yet. Much effort has been devoted to unravel the origin of the extreme helium-rich stars which seem to inhabit the most massive Galactic globular clusters. Yet, the issue of ^{4}He evolution is far from being fully settled even in the disc of the Milky Way.

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Self-consistent simulations of Alfvén wave driven winds from the Sun and stars

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We review our recent results of Alfvén wave-driven winds. First, we present the result of a self-consistent 1D MHD simulations for solar winds from the photosphere to interplanetary region. Here, we emphasize the importance of the reflection of Alfvén waves in the density stratified corona and solar winds. We also introduce the recent HINODE observation that might detect the reflection signature of transverse (Alfvénic) waves by Fujimura & Tsuneta (2009). Then, we show the results of Alfvén wave-driven winds from red giant stars. We explain the change of the atmosphere properties from steady coronal winds to intermittent chromospheric winds and discuss how the wave reflection is affected by the decrease of the surface gravity with stellar evolution. We also discuss similarities and differences of accretion disk winds by MHD turbulence.

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