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Editors: Jacco van Loon and Albert Zijlstra

Editorial

Dear Colleagues,

It is our pleasure to present you the 125$^{\rm th}$ issue of the AGB Newsletter, with 34 refereed journal articles and 12 conference articles, on radio observations, globular clusters, the initial-final mass relation, et cetera. Well done!

We are organising a workshop on super-AGB stars (see the announcement at the end of this issue). Although it is just for one day, London is very easy and cheap to reach and a trip to the workshop can easily be combined with a visit to another institute in the UK or Europe. The list of participants already includes many international experts. If you would like to present a talk please register by 30 November the latest.

The next issue will be distributed on the 1$^{\rm st}$ of December; the deadline for contributions is the 30$^{\rm th}$ of November.

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

Should we call it "Cool Bottom Processing", "extra mixing", "deep mixing", or...?

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 Keck Aperture Masking Experiment: Multi-wavelength observations of 6 Mira Variables

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The angular diameters of six oxygen rich Mira-type long-period variables have been measured at various near-infrared (NIR) wavelengths using the aperture masking technique in an extensive observing program from 1997 Jan to 2004 Sep. These data sets span many pulsation cycles of the observed objects and represent the largest study of multi-wavelength, multi-epoch interferometric angular diameter measurements on Mira stars to date. The calibrated visibility data of *o* Cet, R Leo, R Cas, W Hya, χ Cyg and R Hya are fitted using a uniform disk brightness distribution model to facilitate comparison between epochs, wavelengths and with existing data and theoretical models. The variation of angular diameter as a function of wavelength and time are studied, and cyclic diameter variations are detected for all objects in our sample. These variations are believed to stem from time-dependent changes of density and temperature (and hence varying molecular opacities) in different layers of these stars. The similarities and differences in behaviour between these objects are analyzed and discussed in the context of existing theoretical models. Furthermore, we present time-dependent 3.08 μm angular diameter measurements, probing for the first time these zones of probable dust formation, which show unforeseen sizes and are consistently out of phase with other NIR layers shown in this study. NIR light-curves were recovered, and show the distinctive phase lag in the maxima of ~ 0.2 (compared to the visual maximum), similar to the lag found by, e.g. Smith et al. (2002) and Nadzhip et al. (2001). The S-type Mira χ Cyg exhibits significantly different behaviour compared to the M-type Miras in this study, both in its NIR light-curves and its diameter pulsation signature. Our data show that the NIR diameters predicted by current models are too small and need to incorporate additional and/or enhanced opacity mechanisms. Also, new tailored models are needed to explain the behaviour of the S-type Mira χ Cyg.

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A silicate disk in the heart of the Ant

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We aim at getting high spatial resolution information on the dusty core of bipolar planetary nebulae to directly constrain the shaping process. We present observations of the dusty core of the extreme bipolar planetary nebula Menzel 3 (Mz 3, Hen 2-154, the Ant) taken with the mid-infrared interferometer MIDI/VLTI and the adaptive optics NACO/VLT. The core of Mz 3 is clearly resolved with MIDI in the interferometric mode, whereas it is unresolved from the K_s to the N bands with single dish 8.2m observations on a scale ranging from 60 to 250mas. A striking dependence

of the dust core size with the PA angle of the baselines is observed, that is highly suggestive of an edge-on disk whose major axis is perpendicular to the axis of the bipolar lobes. The MIDI spectrum and the visibilities of Mz 3 exhibit a clear signature of amorphous silicate, in contrast to the signatures of crystalline silicates detected in binary post-AGB systems, suggesting that the disk might be relatively young. We used radiative-transfer Monte Carlo simulations of a passive disk to constrain its geometrical and physical parameters. Its inclination ($74^\circ \pm 3^\circ$) and position angle ($5^\circ \pm 5^\circ$) are in accordance with the values derived from the study of the lobes. The inner radius is 9±1AU and the disk is relatively flat. The dust mass stored in the disk, estimated as 1×10^{-5} $M_\odot$, represents only a small fraction of the dust mass found in the lobes and might be a kind of relic of an essentially polar ejection process.

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Mass loss from dusty, low outflow-velocity AGB stars II. The multiple wind of EP Aquarii

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CO rotational lines are frequently used to trace the outflows from AGB stars. Some profiles are composite, with a narrow component super-imposed on a broader one. These profiles have been interpreted in different ways, calling for episodic mass loss, a bipolar flow, or a circumstellar disk.

To investigate the structure of one of these outflows, we have obtained detailed ^{12}CO(2-1) and ^{12}CO(1-0) maps of EP Aqr, a prototypical source with composite CO profiles.

Interferometric data were acquired with the IRAM interferometer and combined with on-the-fly maps obtained at the IRAM 30-m. The resulting maps in ^{12}CO(2-1) and ^{12}CO(1-0) cover a field of $100'' \times 100''$ with a spectral resolution of 0.1 km s^{-1} and with beams of $1.7'' \times 1.0''$ and $3.5'' \times 1.8''$, respectively.

The source is clearly resolved with a size of about $15''$ (FWHM). We do not observe any obvious departure from circular symmetry, but there is evidence of a ringed structure in the CO(2-1) map with enhanced intensity at $\sim 3.5''$ and $7.5''$ from the central star. The continuum level at 1.3 and 2.6 mm is consistent with the star's photospheric emission. We modeled the spatio-kinematic structure with Monte-Carlo radiative transfer simulations assuming spherical symmetry. We reached a reasonable fit to the map-integrated spectra, but not to the imaging data, possibly because the circumstellar shell of EP Aqr presents inhomogeneities on a scale that is not, or is only barely, resolved in our maps. EP Aqr may be a proto-typical oxygen-rich source for the class of theoretical models exhibiting mass loss variations on a $\sim$ 100 yr timescale discovered by Winters et al. (2000), which show a layered structure in their extended circumstellar shells.

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The Ultraviolet Spectra of the Weak Emission Line Central Stars of Planetary Nebulae

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The ultraviolet spectra of all "weak emission line central stars of planetary nebulae" (WELS) with available IUE data are presented and discussed. We performed line identifications, equivalent width and flux measurements for several features in their spectra. We found that the WELS can be divided in three different groups regarding their UV: i)

Strong P-Cygni profiles (mainly in C IV 1549); ii) Weak P-Cygni features and iii) Absence of P-Cygni profiles. The last group encompasses stars with a featureless UV spectrum or with intense emission lines and a weak continuum, which are most likely of nebular origin. We have measured wind terminal velocities for all objects presenting P-Cygni profiles in N V 1238 and/or C IV 1549. The results obtained were compared to the UV data of the two prototype stars of the [WC]-PG 1159 class, namely, A 30 and A 78. For WELS presenting P-Cygnis, most of the terminal velocities fall in the range $\sim 1000 - 1500$ km s^{-1}, while [WC]-PG 1159 stars possess much higher values, of about 3000 km s^{-1}. The [WC]-PG 1159 stars are characterized by intense, simultaneous P-Cygni emissions in the 1150-2000 Å interval of N V 1238, O V 1371 and C IV 1549. In contrast, we found that O V 1371 is very weak or absent in the WELS spectra. On the basis of the ultraviolet spectra alone, our findings indicate that [WC]-PG 1159 stars are distinct from the WELS, contrary to previous claims in the literature.

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The AGB stars of the intermediate-age LMC cluster NGC 1846. Variability and age determination

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Aims: To investigate variability and to model the pulsational behaviour of AGB variables in the intermediate-age LMC cluster NGC 1846.

Methods: Our own photometric monitoring has been combined with data from the MACHO archive to detect 22 variables among the cluster's AGB stars and to derive pulsation periods. According to the global parameters of the cluster we construct pulsation models taking into account the effect of the C/O ratio on the atmospheric structure. In particular, we have used opacities appropriate for both O-rich stars and carbon stars in the pulsation calculations.

Results: The observed P-L-diagram of NGC 1846 can be fitted using a mass of the AGB stars of about 1.8 $M_\odot$. We show that the period of pulsation is increased when an AGB star turns into a carbon star. Using the mass on the AGB defined by the pulsational behaviour of our sample we derive a cluster age of 1.4×10^9 years. This is the first time the age of a cluster has been derived from the variability of its AGB stars. The carbon stars are shown to be a mixture of fundamental and first overtone radial pulsators.

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Spitzer IRAC Observations of White Dwarfs. I. Warm Dust at Metal-Rich Degenerates

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This paper presents the results of a *Spitzer* IRAC $3 - 8$ μm photometric search for warm dust orbiting 17 nearby, metal-rich white dwarfs, 15 of which apparently have hydrogen dominated atmospheres (type DAZ). G 166-58, G 29-38, and GD 362 manifest excess emission in their IRAC fluxes and the latter two are known to harbor dust grains warm enough to radiate detectable emission at near-infrared wavelengths as short as 2 μm. Their IRAC fluxes display differences compatible with a relatively larger amount of cooler dust at GD 362. G 166-58 is presently unique in that it appears to exhibit excess flux only at wavelengths longer than about 5 μm. Evidence is presented that this mid-infrared emission is most likely associated with the white dwarf, indicating that G 166-58 bears circumstellar dust no

warmer than $T \sim 400$ K. The remaining 14 targets reveal no reliable mid-infrared excess, indicating the majority of DAZ stars do not have warm debris disks sufficiently opaque to be detected by IRAC.

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The First Empirical Mass-Loss Law for Population II Giants

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Using the Spitzer IRAC camera we have obtained mid-IR photometry of the red giant branch stars in the Galactic globular cluster 47 Tuc. About 100 stars show an excess of mid-IR light above that expected from their photospheric emission. This is plausibly due to dust formation in mass flowing from these stars. This mass loss extends down to the level of the horizontal branch and increases with luminosity. The mass loss is episodic, occurring in only a fraction of stars at a given luminosity. Using a simple model and our observations we derive mass-loss rates for these stars. Finally, we obtain the first empirical mass-loss formula calibrated with observations of Population II stars. The dependence on luminosity of our mass-loss rate is considerably shallower than the widely used Reimers law. The results presented here are the first from our Spitzer survey of a carefully chosen sample of 17 Galactic globular clusters, spanning the entire metallicity range from about one hundredth up to almost solar.

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Millimeter observations of Planetary Nebulae: a contribution to the Planck pre-launch catalogue

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We present new millimetre 43 GHz observations of a sample of radio-bright Planetary Nebulae. Such observations were carried out to have a good determination of the high-frequency radio spectra of the sample in order to evaluate, together with far-IR measurements (IRAS), the fluxes emitted by the selected source in the millimetre and sub-millimetre band. This spectral range, even very important to constraint the physics of circumstellar environment, is still far to be completely exploited. To estimate the millimetre and sub-millimetre fluxes, we extrapolated and summed together the ionized gas (free-free radio emission) and dust (thermal emission) contributions at this frequency range. By comparison of the derived flux densities to the foreseen sensitivity we investigate the possible detection of such source for all the channels of the forthcoming ESA's PLANCK mission.

We conclude that almost 80% of our sample will be detected by PLANCK, with the higher detection rate in the higher frequency channels, where there is a good combination of brighter intrinsic flux from the sources and reduced extended Galactic foregrounds contamination despite a worst instrumental sensitivity.

From the new 43 GHz, combined with single-dish 5 GHz observations from the literature, we derive radio spectral indexes, which are consistent with optically thin free-free nebula. This result indicates that the high frequency radio spectrum of our sample sources is dominated by thermal free-free and other emission, if present, are negligible.

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Available from arXiv:0710.1142

ATCA observations of the very young Planetary Nebula SAO 244567

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The radio emission from the youngest known Planetary nebula, SAO 244567, has been mapped at 1384, 2368, 4800, 8640, 16832 and 18752 MHz by using the Australian Telescope Compact Array (ATCA). These observations constitute the first detailed radio study of this very interesting object, as they allow us to obtain the overall radio morphology of the source and to compute, for the first time, the radio spectrum up to millimetre range. Radio emission is consistent with free-free from a wind-like shell, which is also the region where most of the [O III] comes from as revealed by HST images. Physical parameters of the radio nebula and of the central star were derived, all consistent with SAO 244567 being a very young Planetary Nebula still embedded in the dusty remnant of the AGB phase. The optically thin radio flux density appear to decrease when compared to data from the literature. Even very appealing, the variability of the radio emission, probably related to the evolution of the central object, needs further investigations.

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Available from arXiv:0710.1145

Lifetime of OH masers at the tip of the asymptotic giant branch

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Context: A large fraction of otherwise similar asymptotic giant branch stars (AGB) do not show OH maser emission. As shown recently, a restricted lifetime may give a natural explanation as to why only part of any sample emits maser emission at a given epoch.

Aims: We wish to probe the lifetime of 1612 MHz OH masers in circumstellar shells of AGB stars. Methods: We reobserved a sample of OH/IR stars discovered more than 28 years ago to determine the number of stars that may have since lost their masers.

Results: We redetected all 114 OH masers. The minimum lifetime inferred is 2800 years (1 sigma). This maser lifetime applies to AGB stars with strong mass loss leading to very red infrared colors. The velocities and mean flux density levels have not changed since their discovery. As the minimum lifetime is of the same order as the wind crossing time, strong variations in the mass-loss process affecting the excitation conditions on timescales of $\sim$ 3000 years or less are unlikely.

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Dust, pulsation, chromospheres and their role in driving mass loss from red giants in Galactic globular clusters

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Context: Mass loss from red giants in old globular clusters affects the horizontal branch (HB) morphology and post-HB stellar evolution including the production of ultraviolet-bright stars, dredge up of nucleosynthesis products and replenishment of the intra-cluster medium. Studies of mass loss in globular clusters also allows one to investigate the metallicity dependence of the mass loss from cool, low-mass stars down to very low metallicities.

Aims: We present an analysis of new VLT/UVES spectra of 47 red giants in the Galactic globular clusters 47 Tuc (NGC 104), NGC 362, ω Cen (NGC 5139), NGC 6388, M 54 (NGC 6715) and M 15 (NGC 7078). The spectra cover

the wavelength region 6100-9900 Å at a resolving power of $R = 110,000$. Some of these stars are known to exhibit mid-infrared excess emission indicative of circumstellar dust. Our aim is to detect signatures of mass loss, identify the mechanism(s) responsible for such outflows, and measure the mass-loss rates.

Methods: We determine for each star its effective temperature, luminosity, radius and escape velocity. We analyse the Hα and near-infrared calcium triplet lines for evidence of outflows, pulsation and chromospheric activity, and present a simple model for estimating mass-loss rates from the Hα line profile. We compare our results with a variety of other, independent methods.

Results: We argue that a chromosphere persists in Galactic globular cluster giants and controls the mass-loss rate to late-K/early-M spectral types, where pulsation becomes strong enough to drive shock waves at luminosities above the RGB tip. This transition may be metallicity-dependent. We find mass-loss rates of $\sim 10^{-7}$ to 10^{-5} $M_\odot$ yr^{-1}, largely independent of metallicity.

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A Detailed Analysis of the Dust Formation Zone of IRC+10216 Derived from Mid-IR Bands of C_2H_2 and HCN

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A spectral survey of IRC+10216 has been carried out in the range 11 to 14 μm with a spectral resolution of about 4 km s^{-1}. We have identified a forest of lines in six bands of C_2H_2 involving the vibrational states from the ground to $3\nu_5$ and in two bands of HCN, involving the vibrational states from the ground up to $2\nu_2$. Some of these transitions are observed also in H^{13}CCH and H^{13}CN. We have estimated the kinetic, vibrational, and rotational temperatures, and the abundances and column densities of C_2H_2 and HCN between 1 and 300 $R_\star$ ($\simeq 1.5 \times 10^{16}$ cm) by fitting about 300 of these ro-vibrational lines. The envelope can be divided into three regions with approximate boundaries at 0.019″ (the stellar photosphere), 0.1″ (the inner dust formation zone), and 0.4″ (outer dust formation zone). Most of the lines might require a large microturbulence broadening. The derived abundances of C_2H_2 and HCN increase by factors of 10 and 4, respectively, from the innermost envelope outwards. The derived column densities for both C_2H_2 and HCN are $\simeq 1.6 \times 10^{19}$ cm^{-2}. Vibrational states up to 3000 K above ground are populated, suggesting pumping by near-infrared radiation from the star and innermost envelope. Low rotational levels can be considered under LTE while those with $J > 20 - 30$ are not thermalized. A few lines require special analysis to deal with effects like overlap with lines of other molecules.

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Point Sources from a Spitzer IRAC Survey of the Galactic Center

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We have obtained Spitzer/IRAC observations of the central $2.0^\circ \times 1.4^\circ$ (280×200 pc^2) of the Galaxy at 3.6-8.0 μm.

A point source catalog of 1,065,565 objects is presented. The catalog includes magnitudes for the point sources at 3.6, 4.5, 5.8, and 8.0 μm, as well as JHK$_s$ photometry from 2MASS. The point source catalog is confusion limited with average limits of 12.4, 12.1, 11.7, and 11.2 magnitudes for [3.6], [4.5], [5.8], and [8.0], respectively. We find that the confusion limits are spatially variable because of stellar surface density, background surface brightness level, and extinction variations across the survey region. The overall distribution of point source density with Galactic latitude and longitude is essentially constant, but structure does appear when sources of different magnitude ranges are selected. Bright stars show a steep decreasing gradient with Galactic latitude, and a slow decreasing gradient with Galactic longitude, with a peak at the position of the Galactic center. From IRAC color-magnitude and color-color diagrams, we conclude that most of the point sources in our catalog have IRAC magnitudes and colors characteristic of red giant and AGB stars.

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The initial-final mass relationship from white dwarfs in common proper motion pairs

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The initial-final mass relationship of white dwarfs, which is poorly constrained, is of paramount importance for different aspects in modern astrophysics. From an observational perspective, most of the studies up to now have been done using white dwarfs in open clusters. In order to improve the initial-final mass relationship we explore the possibility of deriving a semi-empirical relation studying white dwarfs in common proper motion pairs. We have acquired long-slit spectra of the white dwarf members of the selected common proper motion pairs, as well as high resolution spectra of their companions. From these observations, a full analysis of the two members of each common proper motion pair has lead to the initial and final masses of the white dwarfs. These observations have allowed us to provide updated information for the white dwarfs, since some of them were misclassified. This work is the first one in using common proper motion pairs to improve the initial-final mass relationship, and has also allowed to cover the poorly explored low-mass domain. As in the case of studies based on white dwarfs in open clusters, the distribution of the semi-empirical data presents a large scatter, which is higher than the expected uncertainties in the derived values. This suggests that the initial-final mass relationship may not be a single-valued function.

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A Measurement of Proper Motions of SiO Maser Sources in the Galactic Center with the VLBA

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We report on the high-precision astrometric observations of maser sources around the Galactic Center in the SiO

J=1–0 v=1 and 2 lines with the VLBA during 2001 – 2004. With phase-referencing interferometry referred to the radio continuum source Sgr A*, accurate positions of masers were obtained for three detected objects: IRS 10 EE (7 epochs), IRS 15 NE (2 epochs), and SiO 6 (only 1 epoch). Because circumstellar masers of these objects were resolved into several components, proper motions for the maser sources were derived with several different methods. Combining our VLBA results with those of the previous VLA observations, we obtained the IRS 10 EE proper motion of 76 ± 3 km s^{-1} (at 8 kpc) to the south relative to Sgr A*. Almost null proper motion of this star in the east–west direction results in a net transverse motion of the infrared reference frame of about 30 ± 9 km s^{-1} to the west relative to Sgr A*. The proper-motion data also suggests that IRS 10 EE is an astrometric binary with an unseen massive companion.

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JVN observations of H_2O masers around the evolved star IRAS 22480+6002

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We report on the H_2O maser distributions around IRAS 22480+6002 (= IRC+60370) observed with the Japanese VLBI Network (JVN) at three epochs spanning 2 months. This object was identified as a K-type supergiant in 1970s, which was unusual as a stellar maser source. The spectrum of H_2O masers consists of 5 peaks separated roughly equally by a few km/s each. The H_2O masers were spatially resolved into more than 15 features, which spread about 50 mas along the east–west direction. However, no correlation was found between the proper motion vectors and their spatial distributions; the velocity field of the envelope seems random. A statistical parallax method applied to the observed proper-motion data set gives a distance of 1.0 ± 0.4 kpc for this object, that is considerably smaller than previously thought. The distance indicates that this is an evolved star with $L \sim 5800$ L$_\odot$. This star shows radio, infrared, and optical characteristics quite similar to those of the population II post-AGB stars such as RV Tau variables.

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IC 4406: a radio-infrared view

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IC 4406 is a large (about $100'' \times 30''$) southern bipolar planetary nebula, composed of two elongated lobes extending from a bright central region, where there is evidence for the presence of a large torus of gas and dust. We show new observations of this source performed with IRAC (Spitzer Space Telescope) and the Australia Telescope Compact Array. The radio maps show that the flux from the ionized gas is concentrated in the bright central region and originates in an intricate structure previously observed in Hα, while in the infrared images filaments and clumps can be seen in the extended nebular envelope, the central region showing toroidal emission. Modeling of the infrared emission leads to the conclusion that several dust components are present in the nebula.

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EG And: FUSE and HST/STIS Monitoring of an Eclipsing Symbiotic Binary

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We present highlights and an overview of 20 *FUSE* and *HST*/STIS observations of the bright symbiotic binary EG And. The main motivation behind this work is to obtain spatially-resolved information on an evolved giant star in order to understand the mass-loss processes at work in these objects. The system consists of a low-luminosity white dwarf and a mass-losing, non-dusty M2 giant. The ultraviolet observations follow the white dwarf continuum through periodic gradual occultations by the wind and chromosphere of the giant, providing a unique diagnosis of the circumstellar gas in absorption. Unocculted spectra display high ionization features, such as the O VI resonance doublet which is present as a variable (*hourly* time-scales), broad wind profile, which diagnose the hot gas close to the dwarf component. Spectra observed at stages of partial occultation display a host of low-ionization, narrow, absorption lines, with transitions observed from lower energy levels up to ∼5 eV above ground. This absorption is due to chromospheric/wind material, with most lines due to transitions of Si II, P II, N I, Fe II and Ni II, as well as heavily damped H I Lyman series features. No molecular features are observed in the wind acceleration region despite the sensitivity of *FUSE* to H_2. From analysis of the ultraviolet dataset, as well as optical data, we find that the dwarf radiation does not dominate the wind acceleration region of the giant, and that observed thermal and dynamic wind properties are most likely representative of isolated red giants.

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Initial-Final Mass Relationship for stars of different metallicities

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The initial-final mass relationship (IFMR) for stars is important in many astrophysical fields, such as the evolution of galaxies, the properties of type Ia supernovae (SNe Ia) and the components of dark matter in the Galaxy. The purpose of this paper is to obtain the dependence of the IFMR on metallicity.

Following Paczyński & Ziólkowski (1968) and Han et al. (1994), we assume that the envelope of an asymptotic giant branch (AGB) or a first giant branch (FGB) star is lost when the binding energy of the envelope is equal to zero ($\Delta W = 0$) and the core mass of the AGB star or the FGB star at the point ($\Delta W = 0$) is taken as the final mass. Using this assumption, we calculate the IFMRs for stars of different metallicities.

We find that the IFMRs depends strongly on the metallicity, i.e. $Z = 0.0001$, 0.0003, 0.001, 0.004, 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.08 and 0.1. From $Z = 0.04$, the final mass of the stars with a given initial mass increases with increasing or decreasing metallicity. The difference of the final mass due to the metallicity may be up to 0.4 $M_\odot$. A linear fit of the initial-final mass relationship in NGC 2099 (M 37) shows a potential evidence of the effect of metallicity on the IFMR. The IFMR for stars of $Z = 0.02$ obtained in the paper matches well with those inferred observationally in the Galaxy. For $Z \geq 0.02$, helium WDs are obtained from the stars of $M_i \leq 1.0$ $M_\odot$ and this result is upheld by the discovery of numerous low-mass WDs in NGC 6791 which is a metal-rich old open cluster. Using the IFMR for stars of $Z = 0.02$ obtained in the paper, we have reproduced the mass distribution of DA WDs in Sloan DR4 except for some ultra-massive white dwarfs. The trend that the mean mass of WDs decreases with effective temperature may originate from the increase of the initial metallicities of stars.

We briefly discuss the potential effects of the IFMR on SNe Ia and at the same time, predict that metal-rich low-mass stars may become under-massive white dwarfs.

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Rubidium and lead abundances in giant stars of the globular clusters M 4 and M 5

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We present measurements of the neutron-capture elements Rb and Pb for bright giants in the globular clusters M 4 and M 5. The clusters are of similar metallicity ([Fe/H] = −1.2) but M 4 is decidedly s-process enriched relative to M 5: [Ba/Fe] = +0.6 for M 4 but 0.0 for M 5. The Rb and Pb abundances were derived by comparing synthetic spectra with high-resolution, high signal-to-noise ratio spectra obtained with MIKE on the Magellan telescope. Abundances of Y, Zr, La, and Eu were also obtained. In M 4, the mean abundances from 12 giants are [Rb/Fe] = 0.39 ± 0.02 (σ = 0.07), [Rb/Zr] = 0.17 ± 0.03 (σ = 0.08), and [Pb/Fe] = 0.30 ± 0.02 (σ = 0.07). In M 5, the mean abundances from two giants are [Rb/Fe] = 0.00 ± 0.05 (σ = 0.06), [Rb/Zr] = 0.08 ± 0.08 (σ = 0.11), and [Pb/Fe] = −0.35 ± 0.02 (σ = 0.04). Within the measurement uncertainties, the abundance ratios [Rb/Fe], [Pb/Fe] and [Rb/X] for X = Y, Zr, La are constant from star-to-star in each cluster and none of these ratios are correlated with O or Na abundances. While M 4 has a higher Rb abundance than M 5, the ratios [Rb/X] are similar in both clusters indicating that the nature of the s-products are very similar for each cluster but the gas from which M 4's stars formed had a higher concentration of these products.

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It's a wonderful tail: the mass loss history of Mira

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Recent observations of the Mira AB binary system have revealed a surrounding arc-like structure and a stream of material stretching 2 degrees away in opposition to the arc. The alignment of the proper motion vector and the arc-like structure shows the structures to be a bow shock and accompanying tail. We have successfully hydrodynamically modelled the bow shock and tail as the interaction between the asymptotic giant branch (AGB) wind launched from Mira A and the surrounding interstellar medium. Our simulations show that the wake behind the bow shock is turbulent: this forms periodic density variations in the tail similar to those observed. We investigate the possiblity of mass-loss variations, but find that these have limited effect on the tail structure. The tail is estimated to be approximately 450,000 years old, and is moving with a velocity close to that of Mira itself. We suggest that the duration of the high mass-loss phase on the AGB may have been underestimated. Finally, both the tail curvature and the rebrightening at large distance can be qualitatively understood if Mira recently entered the Local Bubble. This is estimated to have occured 17 pc downstream from its current location.

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The Optical Gravitational Lensing Experiment. Period-Luminosity Relations of Variable Red Giant Stars

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Period–luminosity (PL) relations of variable red giants in the Large (LMC) and Small Magellanic Clouds (SMC) are presented. The PL diagrams are plotted in three planes: $\log P$–K_S, $\log P$–W_{JK}, and $\log P$–W_I, where W_{JK} and W_I are reddening free Wesenheit indices. Fourteen *PL* sequences are distinguishable, and some of them consist of three closely spaced ridges. Each of the sequences is fitted with a linear or quadratic function. The similarities and differences between the *PL* relations in both galaxies are discussed for four types of red giant variability: OGLE Small Amplitude Red Giants (OSARGs), Miras and Semiregular Variables (SRVs), Long Secondary Periods (LSPs) and ellipsoidal variables.

We propose a new method of separating OSARGs from non-variable stars and SRVs. The method employs the position in the reddening-free *PL* diagrams and the characteristic period ratios of these multiperiodic variables. The *PL* relations for the LMC OSARG are compared with the calculated relations for RGB models along isochrones of relevant ages and metallicities. We also compare measured periods and amplitudes of the OSARGs with predictions based on the relations valid for less luminous solar-like pulsators.

Miras and SRVs seem to follow *PL* relation of the same slopes in the LMC and SMC, while for LSP and ellipsoidal variables slopes in both galaxies are different. The *PL* sequences defined by LSP variables and binary systems overlap in the whole range of analyzed wavebands. We put forward new arguments for the binary star scenario as an explanation of the LSP variability and elaborate on it further. The measured pulsation to orbital period ratio implies nearly constant ratio of the star radius to orbital distance, $R/A \approx 0.4$, as we find. Combined effect of tidal friction and mass loss enhanced by the low-mass companion may explain why such a value is preferred.

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The Nearby and Extremely Metal-Poor Galaxy CGCG 269-049

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We present Hubble Space Telescope (*HST*) and Spitzer Space Telescope images and photometry of the extremely metal-poor ($Z = 0.03$ $Z_\odot$) blue dwarf galaxy CGCG 269-049. The *HST* images reveal a large population of red giant and asymptotic giant branch stars, ruling out the possibility that the galaxy has recently formed. From the magnitude of the tip of the red giant branch, we measure a distance to CGCG 269-049 of only 4.9 ± 0.4 Mpc. The spectral energy distribution of the galaxy between ∼3.6 - 70 μm is also best fitted by emission from predominantly ∼10 Gyr stars, with a component of thermal dust emission having a temperature of 72 ± 10 K. The *HST* and *Spitzer* photometry indicate that more than 60% of CGCG 269-049's stellar mass consists of stars ∼10 Gyr old, similar to other local blue dwarf galaxies. Our *HST* Hα image shows no evidence of a supernova-driven outflow that could be removing metals from the galaxy, nor do we find evidence occurred in the past. Taken together with CGCG 269-049's large ratio of neutral hydrogen mass to stellar mass (∼10), these results are consistent with recent simulations in which the metal deficiency of local dwarf galaxies results mainly from inefficient star formation, rather than youth or the escape of supernova ejecta.

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Massive expanding torus and fast outflow in planetary nebula NGC 6302

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We present interferometric observations of ^{12}CO and ^{13}CO J=2−1 emission from the butterfly-shaped, young planetary nebula NGC 6302. The high angular resolution and high sensitivity achieved in our observations allow us to resolve the nebula into two distinct kinematic components: (1) a massive expanding torus seen almost edge-on and oriented in the North-South direction, roughly perpendicular to the optical nebula axis. The torus exhibits very complex and fragmentated structure; (2) high velocity molecular knots moving at high velocity, higher than 20 km s^{-1}, and located in the optical bipolar lobes. These knots show a linear position-velocity gradient (Hubble-like flow), which is characteristic of fast molecular outflow in young planetary nebulae. From the low but variable ^{12}CO/^{13}CO J=2−1 line intensity ratio we conclude that the ^{12}CO J=2−1 emission is optically thick over much of the nebula. Using the optically thinner line ^{13}CO J=2−1 we estimate a total molecular gas mass of $\sim$ 0.1 M$_\odot$, comparable to the ionized gas mass; the total gas mass of the NGC 6302 nebula, including the massive ionized gas from photon dominated region, is found to be $\sim$ 0.5 M$_\odot$. From radiative transfer modelling we infer that the torus is seen at inclination angle of 75° with respect to the plane of the sky and expanding at velocity of 15 km s^{-1}. Comparison with recent observations of molecular gas in NGC 6302 is also discussed.

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Dust mass-loss rates from AGB stars in the Fornax and Sagittarius dwarf Spheroidal galaxies

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To study the effect of metallicity on the mass-loss rate of asymptotic giant branch (AGB) stars, we have conducted mid-infrared photometric measurements of such stars in the Sagittarius (Sgr dSph) and Fornax dwarf spheroidal galaxies with the 10-μm camera VISIR at the VLT. We derive mass-loss rates for 29 AGB stars in Sgr dSph and 2 in Fornax. The dust mass-loss rates are estimated from the $K-[9]$ and $K-[11]$ colours. Radiative transfer models are used to check the consistency of the method. Published IRAS and Spitzer data confirm that the same tight correlation between $K-[12]$ colour and dust mass-loss rates is observed for AGB stars from galaxies with different metallicities, i.e. the Galaxy, the LMC and the SMC.

The derived dust mass-loss rates are in the range 5×10^{-10} to 3×10^{-8} M$_\odot$ yr^{-1} for the observed AGB stars in Sgr dSph and around 5×10^{-9} M$_\odot$ yr^{-1} for those in Fornax; while values obtained with the two different methods are of the same order of magnitude. The mass-loss rates for these stars are higher than the nuclear burning rates, so they will terminate their AGB phase by the depletion of their stellar mantles before their core can grow significantly. Some observed stars have lower mass-loss rates than the minimum value predicted by theoretical models.

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The Initial-Final Mass Relation: Direct Constraints at the Low Mass End

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The initial-final mass relation represents a mapping between the mass of a white dwarf remnant and the mass that the hydrogen burning main-sequence star that created it once had. The empirical relation thus far has been constrained using a sample of ∼40 stars in young open clusters, ranging in initial mass from ∼2.75 – 7 $M_\odot$, and shows a general trend that connects higher mass main-sequence stars with higher mass white dwarfs. In this paper, we present CFHT/CFH12K photometric and Keck/LRIS multiobject spectroscopic observations of a sample of 22 white dwarfs in two *older* open clusters, NGC 7789 ($t = 1.4$ Gyr) and NGC 6819 ($t = 2.5$ Gyr). At these ages, stars in these clusters with masses as low as 1.6 $M_\odot$ have already evolved off the main sequence and formed white dwarfs. We measure masses for the highest S/N spectra by fitting the Balmer lines to atmosphere models and place the first direct constraints on the low mass end of the initial-final mass relation. Our results indicate that the observed general trend at higher masses continues down to low masses, with $M_{\rm initial} = 1.6$ $M_\odot$ main-sequence stars forming $M_{\rm final} = 0.54$ $M_\odot$ white dwarfs. When added to our new data from the very old cluster NGC 6791, the relation is extended down to $M_{\rm initial} = 1.16$ $M_\odot$ (corresponding to $M_{\rm final} = 0.53$ $M_\odot$). This extension of the relation represents a four fold increase in the total number of hydrogen burning stars for which the integrated mass loss can now be calculated from empirical data, assuming a Salpeter initial mass function. The new leverage at the low mass end is used to derive a purely empirical initial-final mass relation for the entire sample of stars, without the need for any indirectly measured anchor points. The sample of white dwarfs in these clusters also shows several very interesting systems that we discuss further: a DB (helium atmosphere) white dwarf, a magnetic white dwarf, a DAB (mixed hydrogen/helium atmosphere or a double degenerate DA+DB) white dwarf(s), and two possible equal mass DA double degenerate binary systems.

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Kinematic structure of the atmosphere and envelope of the post-AGB star HD 56126.

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We present results of an analysis of the optical spectrum of the post-AGB star HD 56126 (IRAS 07134+1005) based on observations made with the echelle spectrographs of the 6-m telescope ($R = 25000$ and 60000 at 4012-8790 Å). The profiles of strongest lines (H I; Fe II, Y II, Ba II absorptions, etc.) formed in the expanding atmosphere at the base of the stellar wind have complex and variable shapes. To study the kinematics of the atmosphere, the velocities of individual features in these profiles must be measured. Differential line shifts of up to $V_{\rm r} = 15 - 30$ km s^{-1} have been detected from the lines of metals and molecular features. The star's atmosphere simultaneously contains both expanding layers and layers falling onto the star. A comparison of the data for different times demonstrates that both the radial velocity and the velocity pattern in whole are variable. The position of the molecular spectrum is stable, implying stability of the expansion velocity of the circumstellar envelope around HD 56126 detected in observations in the C_2 and Na I lines.

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Highly He-Rich Matter Dredged Up by Extra Mixing through Stellar Encounters in Globular Clusters

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The unveiled main-sequence splitting in ω Centauri as well as NGC 2808 suggests that matter highly-enriched in He (in terms of its mass fraction $Y \sim 0.4$) was produced and made the color of some main-sequence stars bluer in these globular clusters (GCs). The potential production site for the He-rich matter is generally considered to be massive AGB stars that experience the second dredge-up. However, it is found that massive AGB stars provide the matter with $Y \sim 0.35$ at most, while the observed blue-shift requires the presence of $Y \sim 0.4$ matter. Here, we show that extra mixing, which operates in the red giant phase of stars less massive than ~ 2 $M_\odot$, could be a mechanism that enhances He content in their envelopes up to $Y \sim 0.4$. The extra mixing is supposed to be induced by red giant encounters with other stars in a collisional system like GCs. The $Y \sim 0.4$ matter released in the AGB phase has alternative fates to (i) escape from a GC or (ii) be captured by kinematically cool stars through encounters. The AGB ejecta in ω Cen, which follows the latter case, can supply sufficient He to cause the observed blue-shift. Simultaneously, this scheme generates the extreme horizontal branch, as observed in ω Cen in response to the higher mass loss rates, which is also caused by stellar encounters.

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Water vapor emission from IRC+10216 and other carbon-rich stars: model predictions and prospects for multitransition observations

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We have modeled the emission of H_2O rotational lines from the extreme C-rich star IRC+10216. Our treatment of the excitation of H_2O emissions takes into account the excitation of H_2O both through collisions, and through the pumping of the ν_2 and ν_3 vibrational states by dust emission and subsequent decay to the ground state. Regardless of the spatial distribution of the water molecules, the H_2O $1_{10}-1_{01}$ line at 557 GHz observed by the *Submillimeter Wave Astronomy Satellite* (SWAS) is found to be pumped primarily through the absorption of dust-emitted photons at 6 μm in the ν_2 band. As noted by previous authors, the inclusion of radiative pumping lowers the ortho-H_2O abundance required to account for the 557 GHz emission, which is found to be $(0.5-1)\times10^{-7}$ if the presence of H_2O is a consequence of vaporization of orbiting comets or Fischer-Tropsch catalysis. Predictions for other submillimeter H_2O lines that can be observed by the *Herschel Space Observatory* (HSO) are reported. Multitransition HSO observations promise to reveal the spatial distribution of the circumstellar water vapor, discriminating among the several hypotheses that have been proposed for the origin of the H_2O vapor in the envelope of IRC+10216. We also show that, for observations with HSO, the H_2O $1_{10}-1_{01}$ 557 GHz line affords the greatest sensitivity in searching for H_2O in other C-rich AGB stars.

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Silicate dust in the environment of RS Ophiuchi following the 2006 eruption

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We present further Spitzer Space Telescope observations of the recurrent nova RS Ophiuchi, obtained over the period 208-430 days after the 2006 eruption. The later Spitzer IRS data show that the line emission and free-free continuum emission reported earlier is declining, revealing incontrovertible evidence for the presence of silicate emission features at 9.7 and 18 μm. We conclude that the silicate dust survives the hard radiation impulse and shock blast wave from the eruption. The existence of the extant dust may have significant implications for understanding the propagation of shocks through the red giant wind and likely wind geometry.

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WD 0433+270: an old Hyades stream member or an Fe-core white dwarf?

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G 39-27/289 is a common proper motion pair formed by a white dwarf (WD 0433+270) and a main-sequence star (BD+26 730) that apparently has been classified as a member of the Hyades open cluster. Previous studies of the white dwarf component yielded a cooling time of $\sim$ 4 Gyr. Although it has not been pointed out before explicitly, this result is 6 times larger than the age of the Hyades cluster, giving rise to an apparent conflict between the physics of white dwarfs and cluster main-sequence fitting. We investigate whether this system belongs to the Hyades cluster and, accordingly, give a plausible explanation to the nature of the white dwarf member. From kinematic and chemical composition considerations we believe that the system was a former member of the Hyades cluster and therefore has an evolutionary link with it. However, the evidence is not conclusive. With regards to the nature of the white dwarf component, we find that two core compositions (C/O and Fe) are compatible with the observed effective temperature and radius. These compositions yield very different cooling times of $\sim$ 4 Gyr and $\sim$ 1 Gyr, respectively. We distinguish two posssible scenarios. If the pair does not belong to the Hyades cluster but only to the Hyades stream, this would indicate that such stream contains rather old objects and definitely not coeval with the cluster. This has interesting consequences for Galactic dynamics. On the contrary, if the white dwarf has an Fe core, it will have a cooling time

compatible with the Hyades age. This is a tantalizing result that would have implications for the thermonuclear explosion of white dwarfs and explosion theories of degenerate nuclei.

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ISM dust feedback from low to high mass stars

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The dust component of the interstellar medium (ISM) has been extensively studied in the past decades. Late-type stars have been assumed as the main source of dust to the ISM, but recent observations show that supernova remnants may play a role on the ISM dust feedback. In this work, I study the importance of low and high mass stars, as well as their evolutionary phase, on the ISM dust feedback process. I also determine the changes on the obtained results considering different mass distribution functions and star formation history. I describe a semi-empirical calculation of the relative importance of each star at each evolutionary phase in the dust ejection to the ISM. I compare the obtained results for two stellar mass distribution functions, the classic Salpeter initial mass function and the present day mass function. I used the evolutionary track models for each stellar mass, and the empirical mass-loss rates and dust-to-gas ratio. The relative contribution of each stellar mass depends on the used distribution. Ejecta from massive stars represent the most important objects for the ISM dust replenishment using the Salpeter IMF. On the other hand, for the present day mass function low and intermediate mass stars are dominant. Late-type giant and supergiant stars dominate the ISM dust feedback in our actual Galaxy, but this may not the case of galaxies experiencing high star formation rates, or at high redshifts. In those cases, SNe are dominant in the dust feedback process.

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A multi-transition submillimeter water maser study of evolved stars – detection of a new line near 475 GHz

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Context: Maser emission from the H_2O molecule probes the warm, inner circumstellar envelopes of oxygen-rich red giant and supergiant stars. Multi-maser transition studies can be used to put constraints on the density and temperature of the emission regions.

Aims: A number of known H_2O maser lines were observed toward the long period variables R Leo and W Hya and the red supergiant VY CMa. A search for a new, not yet detected line near 475 GHz was conducted toward these stars.

Methods: The Atacama Pathfinder Experiment telescope was used for a multi-transition observational study of submillimeter H_2O lines.

Results: The $5_{33} - 4_{40}$ transition near 475 GHz was clearly detected toward VY CMa and W Hya. Many other H_2O lines were detected toward all three target stars. Relative line intensity ratios and velocity widths were found to vary significantly from star to star.

Conclusions: Maser action is observed in all but one line for which it was theoretically predicted. In contrast, one of the strongest maser lines, in R Leo by far the strongest, the 437 GHz $7_{53} - 6_{60}$ transition, is not predicted to be inverted. Some other qualitative predictions of the model calculations are at variance with our observations. Plausible reasons for this are discussed. Based on our findings for W Hya and VY CMa, we find evidence that the H_2O masers

in the AGB star W Hya arise from the regular circumstellar outflow, while shock excitation in a high velocity flow seems to be required to excite masers far from the red supergiant VY CMa.

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SPITZER SAGE Observations of Large Magellanic Cloud Planetary Nebulae

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We present IRAC and MIPS images and photometry of a sample of previously known planetary nebulae (PNe) from the SAGE survey of the Large Magellanic Cloud (LMC) performed with the Spitzer Space Telescope. Of the 233 known PNe in the survey field, 185 objects were detected in at least two of the IRAC bands, and 161 detected in the MIPS 24 μm images. Color-color and color-magnitude diagrams are presented using several combinations of IRAC, MIPS, and 2MASS magnitudes. The location of an individual PN in the color-color diagrams is seen to depend on the relative contributions of the spectral components which include molecular hydrogen, polycyclic aromatic hydrocarbons (PAHs), infrared forbidden line emission from the ionized gas, warm dust continuum, and emission directly from the central star. The sample of LMC PNe is compared to a number of Galactic PNe and found to not significantly differ in their position in color-color space. We also explore the potential value of IR PNe luminosity functions (LFs) in the LMC. IRAC LFs appear to follow the same functional form as the well-established [O III] LFs although there are several PNe with observed IR magnitudes brighter than the cut-offs in these LFs.

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Conference Papers

Yields from AGB Stars and their Impact on the Chemical Evolution of Dwarf Galaxies

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By means of 2–D chemodynamical simulations, we study the evolution of dwarf galaxies with structural parameters

similar to I Zw 18 and to tidal dwarf galaxies. Different sets of yields from intermediate-mass stars are tested, in order to discover which one best reproduces the observed chemical compositions (in particular for nitrogen). Different choices of yields from intermediate-mass stars lead to differences of up to 0.3–0.6 dex, depending on the assumptions. It is also shown that, given the dependence of the cooling function on the metallicity, the dynamics of galaxies is also significantly affected by the choice of nucleosynthetic yields.

Oral contribution, published in "Why Galaxies Care about AGB Stars", held in Vienna, August 7-11, 2006; eds. F. Kerschbaum, C. Charbonnel & B. Wing, ASP Conf.Ser.
Available from arXiv:0709.3318

Jets and Tori in Proto-Planetary Nebulae: Observations vs. Theory

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We report on a study of the time sequence for the appearance of high-velocity jets and equatorial tori in the transition of stars from the asymptotic giant branch to the planetary nebulae phase. Jets and tori are prominent features of this evolution, but their origins are uncertain. Using the kinematics of molecular tori and molecular or optical jets, we determine the ejection histories for a sample of well-observed cases. We find that jets and tori develop nearly simultaneously. We also find evidence that jets appear slightly later than tori, with a typical jet-lag of a few hundred years. The reconstructed time-lines of this sequence provide good evidence that jets and tori are physically related, and they set new constraints on jet formation scenarios. Some scenarios are ruled out or rendered implausible, and others are challenged at a quantitative level.

Oral contribution, published in "Asymmetrical Planetary Nebulae IV", eds. R.L.M. Corradi, A. Manchado & N. Soker
Available from arXiv:0709.3539

Metallicity and mean age across M 33

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New wide-field near-infrared (NIR) imaging observations of M 33 were obtained from UKIRT. These show a large population of intermediate-age stars considerably improving on previous NIR data. The spatial distribution of super giant stars, carbon-rich (C-rich or C stars) and oxygen-rich (O-rich or M stars) asymptotic giant branch (AGB) stars distinguished from the NIR colour-magnitude diagram (CMD) have been studied as well as the C/M ratio. The K_s magnitude distribution has been interpreted using theoretical models to derive the mean age and the mean metallicity across M 33.

Oral contribution, published in "Galaxies in the Local Volume", Sydney 8-13 July 2007, Springer Astrophysics and Space Science Proceedings, eds. B. Koribalski & H. Jerjen
Available from arXiv:0709.2949

A disc in the heart of the Ant nebula

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We present the discovery of a silicate disc at the centre of the planetary nebula Mz 3 (the Ant). The nebula was observed with MIDI on the Very Large Telescope Interferometer (VLTI). The visibilities obtained at different orientations clearly indicate the presence of a dusty, nearly edge-on disc in the heart of the nebula. An amorphous silicate absorption feature is clearly seen in our mid-IR spectrum and visibility curves. We used radiative transfer Monte Carlo simulations to constrain the geometrical and physical parameters of the disc. We derive an inner radius of 9 AU (~ 6 mas assuming $D = 1.4$ kpc). This disc is perpendicular to, but a factor of 10^3 smaller than the optical bipolar outflow.

Poster contribution, published in Asymmetrical Planetary Nebulae IV
Available from arXiv:0710.0540

Structural and Nucleosynthetic Evolution of Metal-poor and Metal-free Low and Intermediate Mass Stars

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We report on an investigation into stellar evolution and nucleosynthesis in the low and extremely low metallicity regime, including models of stars with a pure Big Bang composition (i.e. $Z = 0$). The metallicity range of the extremely metal poor (EMP) models we have calculated is $-6.5 < [\mathrm{Fe/H}] < -3.0$, whilst our models are in the mass range $0.85 < M < 3.0$ $\mathrm{M}_{\odot}$. Many of the EMP and $Z = 0$ models experience violent evolutionary episodes not seen at higher metallicities. We refer to these events as 'Dual Flashes' since they are characterised by peaks in the hydrogen and helium burning luminosities occurring at roughly the same time. Some of the material processed by these events is later dredged up by the convective envelope, causing signifcant surface pollution. These events have been reported by previous studies, so our results reaffirm their occurrence — at least in 1D stellar models. The novelty of this study is that we have calculated the entire evolution of the $Z = 0$ and EMP models, from the ZAMS to the end of the TPAGB, including detailed nucleosynthesis. We have also calculated the nucleosynthetic yields, which will soon be available in electronic format. Although subject to many uncertainties these are, as far as we are aware, the only yields available in this mass and metallicity range. In this paper we briefy describe some of the results in the context of abundance observations of EMP halo stars. This work formed part of SWC's PhD thesis (completed in March 2007) and a series of subsequent papers will describe the results of the study in more detail.

Oral contribution, published in "First Stars III", eds. B. O'Shea, A. Heger & T. Abel
Available from arXiv:0709.4567
and from http://www.asiaa.sinica.edu.tw/∼simcam/

Abundance Patterns in Stars in the Bulge and Galactic Center

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We discuss oxygen and iron abundance patterns in K and M red-giant members of the Galactic bulge and in the young and massive M-type stars inhabiting the very center of the Milky Way. The abundance results from the different bulge

studies in the literature, both in the optical and the infrared, indicate that the [O/Fe]-[Fe/H] relation in the bulge does not follow the disk relation, with [O/Fe] values falling above those of the disk. Based on these elevated values of [O/Fe] extending to large Fe abundances, it is suggested that the bulge underwent a rapid chemical enrichment with perhaps a top-heavy initial mass function. The Galactic Center stars reveal a nearly uniform and slightly elevated (relative to solar) iron abundance for a studied sample which is composed of 10 red giants and supergiants. Perhaps of more significance is the fact that the young Galactic Center M-type stars show abundance patterns that are reminiscent of those observed for the bulge population and contain enhanced abundance ratios of alpha-elements relative to either the Sun or Milky Way disk at near-solar metallicities.

Oral contribution, published in "Formation and Evolution of Galaxy Bulges", IAU Symposium 245
Available from arXiv:0710.0866

Radio and Infrared observations of Transition Objects

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Observing objects in transition from pre- to young Planetary Nebula (PN), when the central star radiation starts to excite the envelope, can help us to understand the evolution of the circumstellar ejecta and their shaping mechanism/s. In our project we have selected a sample of hot post-AGB stars as Transition Phase candidates. Radio observations have led to detect free-free radiation from an ionized shell in about half of our targets, providing us with two sub-samples of ionized and non ionized Transition Objects. We are now using IRAC and IRS on the Spitzer Space Telescope to determine if extended emission is present (IRAC) and to study our targets' chemistry (IRS). In particular, by comparing spectra from the two sub-samples, the IRS observations will enable us to check how the presence of an ionization front effects the circumstellar envelope. The IRAC measurements, combined with previous ones in the literature, will give us information on the extent and physical conditions of the dust components.

Oral contribution, published in "Asymmetrical Planetary Nebulae IV", eds. R.L.M. Corradi, A. Manchado & N. Soker
Available from arXiv:0708.4246

Deep study of the fast bipolar outflows in pre-PNe from CO mm-wave line emission

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High spatial resolution images of PNe have shown their extremely complex morphology. However, the circumstellar envelopes of their progenitors, the AGB stars, are strikingly spherical. In order to understand the carving processes leading to axisymmetric nebulae, we are carrying out a study of a large sample of pre-PNe. Our emission model of the nebular molecular gas (^{12}CO & ^{13}CO) will allow us to determine important physical parameters (mass, linear momentum, kinetic energy) of the fast bipolar and slow spherical nebular components separately. We will study in an innovative way the properties for each source individually, and put our results in an evolutionary context with the help of the data obtained by us and collected from the literature.

Poster contribution, published in "Asymmetrical Planetary Nebulae IV"
Available from arXiv:0709.4207

Metal-rich debris discs around white dwarfs

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We have identified two moderately hot (∼18000–22000 K) white dwarfs, SDSS J1228+1040 and SDSS J1043+0855, which exhibit double-peaked emission lines in the Ca II $\lambda\lambda$ 8600 triplet. These line profiles are unambiguous signatures of gaseous discs with outer radii of ~ 1 R$_\odot$ orbiting the two white dwarfs. Both stars accrete from the circumstellar material, resulting in large photospheric Mg abundances. The absence of hydrogen emission from the discs, and helium absorption in the white dwarf photospheres demonstrates that the circumstellar material is depleted in volatile elements, and the most likely origin of these gaseous rings are tidally disrupted rocky asteroids. The relatively high mass of SDSS J1228+1040 implies that planetary systems can not only form around $4-5$ M$_\odot$ stars, but may also survive their post main-sequence evolution.

Oral contribution, published in "Extreme Solar Systems", eds. D. Fischer, F. Rasio, S. Thorsett & A. Wolszczan, ASP Conf.Series
Available from arXiv:0710.2807

Helium stars as supernova progenitors

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We follow the evolution of helium stars of initial mass $(2.2-2.5)$ M$_\odot$, and show that they undergo off-center carbon burning, which leaves behind ~ 0.01 M$_\odot$ of unburnt carbon in the inner part of the core. When the carbon-oxygen core grows to Chandrasekhar mass, the amount of left-over carbon is sufficient to ignite thermonuclear runaway. At the moment of explosion, the star will possess an envelope of several 0.1 M$_\odot$, consisting of He, C, and possibly some H, perhaps producing a kind of peculiar SN. Based on the results of Waldman & Barkat 2007 for accreting white dwarfs, we expect to get thermonuclear runaway at a broad range of $\rho_c \approx (1-6)\times 10^9$ g cm^{-3}, depending on the amount of residual carbon. We verified the feasibility of this scenario by showing that in a close binary system with initial masses $(8.5+7.7)$ M$_\odot$ and initial period of 150 day the primary produces a helium remnant of 2.3 M$_\odot$ that evolves further like the model we considered.

Oral contribution, published in "Hydrogen-Deficient Stars 2007"
Available from arXiv:0710.3911

Historic mass loss from the RS Ophiuchi system

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Dust has been detected in the recurrent nova RS Ophiuchi on several occassions. I model the historical mid-infrared photometry and a recent Spitzer Space Telescope spectrum taken only half a year after the 2006 eruption. The dust envelope is little affected by the eruption. I show evidence that the eruptions and possibly the red giant wind of RS Oph may sculpt the interstellar medium, and show similar evidence for the recurrent dwarf nova T Pyxidis.

Oral contribution, published in "RS Ophiuchi (2006) and the recurrent nova phenomenon", eds. A. Evans, M.F. Bode & T.J. O'Brien, ASP Conf.Ser.
Available from arXiv:0710.5629
and from http://www.astro.keele.ac.uk/∼jacco/research/keele2007.pdf

Review Paper

Physical and Wind Properties of [WC] Stars

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We review the properties of carbon-sequence ([WC]) Wolf-Rayet central stars of planetary nebulae (CSPNe). Differences between the subtype distribution of [WC] stars and their massive WC cousins are discussed. We conclude that [WO]-type differ from early-type [WC] stars as a result of weaker stellar winds due to high surface gravities, and that late- and early-type [WC] and [WO] stars generally span a similar range in abundances, $X(\mathrm{He}) \sim X(\mathrm{C}) \gg X(\mathrm{O})$, consistent with a late thermal pulse, and likely progenitors to PG 1159 stars.

Published in "Hydrogen-Deficient Stars", eds. K. Werner & T. Rauch, ASP Conf.Series
Available from arXiv:0710.5774

Announcement

Super-AGB stars and the fine line between White Dwarf or Supernova

Royal Astronomical Society Specialist Discussion Meeting

London (UK), 8 February 2008

Depending on its initial mass, a star may end as a white dwarf or explode as a supernova. The dividing boundary is however ill-defined, and depends on the treatment of convection and mass loss. Asymptotic Giant Branch (AGB) stars do not ignite carbon and end up as carbon-oxygen white dwarfs. But if mass loss is weak the core may grow to reach the Chandrasekhar mass limit and explode as a thermonuclear supernova. Slightly more massive stars ignite carbon and, like AGB stars, they also undergo thermal pulses. These super-AGB stars may leave an oxygen-neon white dwarf, but their fate is unclear. They will either produce an oxygen-neon white dwarf or explode in an electron capture supernova and produce a neutron star. Red supergiants of initial mass as low as 8 solar masses have now been identified directly as the progenitors of type IIP supernovae. With the Initial Mass Function favouring the low mass end of the supernova progenitors, massive AGB stars contributing to nitrogen enrichment on timescales as short as tens of million years, and both supernovae and AGB stars competing for the title of most prolific dust factory in the early Universe, it is crucial to gain a better understanding of the boundary between massive AGB stars and the progenitors of core-collapse supernovae.

The meeting will start at 10:00 and lasts until 15:30. Besides contributed talks and discussion time, the meeting will be based around three keynote lectures:
"Understood, uncertain and unknown physics of super-AGB stars", Richard Stancliffe, Cambridge University (UK)
"Observational constraints on the most massive white dwarf progenitors", Kurtis Williams, University of Texas (USA)
"Observational constraints on the masses of supernova progenitors", Stephen Smartt, Queen's University Belfast (UK)
with an opening speech and closing remarks provided by Alvio Renzini, Università di Padova (Italia).

Please register by 30 November 2007, especially (with a title and abstract) if you want to propose a talk. Ample space is available for posters.

The meeting is free to all Fellows of the RAS, but make sure you bring along your RAS member card! A small entry fee is charged for non-fellows, collected on the door: 15 pounds Sterling (or 5 pounds with a valid student card).

There will be no traditional proceedings, and hence no burden on your time after the meeting. However, we aim to place all electronic contributions (talks, posters, additional material if appropriate) on the web, and will announce this via the AGB Newsletter, Massive Stars Newsletter and arXiv.org. We also plan to write a summary article for publication in the RAS journal "Astronomy & Geophysics" shortly after the meeting, which we hope will also capture the essence of the discussions that took place.

See you in London!

Jacco van Loon (Keele University) and John Eldridge (Cambridge University)
on behalf of the UK Working Group on Evolved Stars

See also http://www.astro.keele.ac.uk/e-stars/ras2008/ras2008.html