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 199$^{\rm th}$ issue of the AGB Newsletter. We are delighted to have a new co-editor joining us, Dr. Ambra Nanni. Ambra has just graduated from SISSA, Trieste; her specialism is dust formation and AGB outflows but she is rather clever and able more generally.

Sakib Rasool volunteered the following ode to past, recent contributions to our field: The most significant development in PN research since 2005 is the unexpected and valuable contributions of amateur astronomers regarding the discovery of new PNe. Not only have the number of spherical PNe been increased, the number of new evolved PNe being found has helped shape our understanding of the endpoint of PN evolution prior to total dissolution. On the other end of the scale, previously unknown remnants of AGB mass loss have been discovered in the form of newly discovered haloes in deep amateur images. One example of a newly discovered halo is this one around IC 5148 revealed by the amateur Don Goldman: http://www.astrodonimaging.com/gallery/display.cfm?imgID=263

Looking for a postdoctoral research position? There is a fabulous opportunity to work with the brilliant Paola Marigo in Padova, or at Queen's in Belfast.

Your thoughts on the most pressing questions to be tackled in the near future are most welcome, to be presented in the next, 200$^{\rm th}$ issue.

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

Editorially Yours,
Jacco van Loon, Ambra Nanni and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

What are the most pressing issues to resolve in the next hundred months?

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

Spitzer Space Telescope spectra of post-AGB stars in the Large Magellanic Cloud – polycyclic aromatic hydrocarbons at low metallicities

Mikako Matsuura[1], Jerónimo Bernard-Salas[2,3], T. Lloyd Evans[4], Kevin M. Volk [5], Bruce J. Hrivnak[6], G.C. Sloan[7], You-Hua Chu[8], Robert Gruendl[8], Kathleen E. Kraemer[9], Els Peeters[10,11], R. Szczerba[12], P.R. Wood[13], Albert A. Zijlstra[14], S. Hony[15], Yoshifusa Ita[16], Devika Kamath[13], Eric Lagadec[7], Quentin A Parker[17,18,19], Warren A. Reid[17], Takashi Shimonishi[20], H. Van Winckel[21], Paul M. Woods[1,22], F. Kemper[23], Margaret Meixner [5], M. Otsuka[23], R. Sahai[24], B.A. Sargent[25], J.L. Hora[26] and Iain McDonald[14]

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This paper reports variations of polycyclic aromatic hydrocarbons (PAHs) features that were found in *Spitzer* Space Telescope spectra of carbon-rich post-asymptotic giant branch (post-AGB) stars in the Large Magellanic Cloud (LMC). The paper consists of two parts. The first part describes our *Spitzer* spectral observing programme of 24 stars including post-AGB candidates. The latter half of this paper presents the analysis of PAH features in 20 carbon-rich post-AGB stars in the LMC, assembled from the *Spitzer* archive as well as from our own programme. We found that five post-AGB stars showed a broad feature with a peak at 7.7 μm, that had not been classified before. Further, the 10–13 μm PAH spectra were classified into four classes, one of which has three broad peaks at 11.3, 12.3 and 13.3 μm rather than two distinct sharp peaks at 11.3 and 12.7 μm, as commonly found in H II regions. Our studies suggest that PAHs are gradually processed while the central stars evolve from post-AGB phase to PNe, changing their composition before PAHs are incorporated into the interstellar medium. Although some metallicity dependence of PAH spectra exists, the evolutionary state of an object is more significant than its metallicity in determining the spectral characteristics of PAHs for LMC and Galactic post-AGB stars.

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Available from arXiv:1401.0728

Single rotating stars and the formation of bipolar planetary nebulæ

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We have computed new stellar evolution models that include the effects of rotation and magnetic torques under different hypothesis. The goal is to test if a single star can sustain in the envelope the rotational velocities needed for the magneto hydrodynamical (MHD) simulations to shape bipolar Planetary Nebulæ (PNe) when the high mass-loss rates take place. Stellar evolution models with main sequence masses of 2.5 and 5 $M_{\odot}$, and initial rotational velocities of 250 km s^{-1} have been followed all the way to the PNe formation phase. We find that stellar cores have to be spun down using magnetic torques in order to reproduce the rotation rates observed for white dwarfs. During the asymptotic giant branch phase and beyond, the magnetic braking of the core has a practically null effect in increasing the rotational velocity of the envelope since the stellar angular momentum is removed efficiently by the wind. We have, as well, tested best possible case scenarios in rather non-physical contexts to give enough angular momentum to the envelope. We find that we cannot get the envelope of a single star rotating at the speeds needed by the MHD simulations to form bipolar PNe. We conclude that single stellar rotators are unlikely to be the progenitors of bipolar PNe under the current MHD model paradigm.

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A multiwavelength analysis of planetary nebulæ in the Large Magellanic Cloud

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This paper examines, compares and plots optical, near- and mid-infrared (MIR) photometric data for 605 planetary nebulæ (PNe) in the Large Magellanic Cloud (LMC). With the aid of multi-wavelength surveys such as the *Spitzer* legacy programme Surveying the Agents of a Galaxy's Evolution, the Two Micron All Sky Survey and the Magellanic Cloud Photometric Survey, plots have been constructed to expose the relative contributions from molecular hydrogen, polycyclic aromatic hydrocarbons, forbidden emission lines, warm dust continuum and stellar emission at various bands. Besides identifying trends, these plots have helped to reveal PN mimics including six previously known PNe in the outer LMC which are re-classified as other object types. Together with continuing follow-up optical observations, the data have enabled a substantial reduction in the number of PNe previously tagged as 'likely' and 'possible'. The total number of LMC PNe is adjusted to 715 but with a greater degree of confidence in regard to classification. In each colour–colour plot, the more highly evolved LMC PNe are highlighted for comparison with younger, brighter PNe. The faintest and most evolved PNe typically cluster in areas of colour–colour space occupied by ordinary stars. Possible reasons for the wide disparity in infrared colour–colour ratios, such as evolution and dust composition, are presented for evaluation. A correlation is found between the optical luminosity of PNe, emission-line ratios and the MIR dust luminosity at various bands. Luminosity functions using the four Infrared Array Camera and Multiband Imaging Photometer of *Spitzer* (MIPS) [24] bands are directly compared, revealing an increasing accumulation of PNe within the brightest two magnitudes at longer wavelengths. A correlation is also found between the MIPS [24] band and the [O III] 5007 and Hβ fluxes.

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VISTA variables in the Sagittarius dwarf spheroidal galaxy: pulsation- vs. dust-driven winds on the giant branches

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Variability is examined in over 2.6 million stars covering 11 square degrees of the core of the Sagittarius dwarf spheroidal galaxy (Sgr dSph) from VISTA z-band observations. Generally, pulsation on the Sgr dSph giant branches appears to be excited by the internal κ mechanism. Pulsation amplitudes appear identical between red and asymptotic (RGB/AGB) giant stars, and between unreddened carbon and oxygen-rich stars at the same luminosity. The lack of correlation between infrared excess and variability among oxygen-rich stars indicates pulsations do not contribute significantly to wind driving in oxygen-rich stars in the Sgr dSph, though the low amplitudes of these stars mean this may not apply elsewhere. The dust-enshrouded carbon stars have the highest amplitudes of the stars we observe. Only in these stars does an external κ-mechanism-driven pulsation seem likely, caused by variations in their more-opaque carbon-rich molecules or dust. This may allow pulsation driving of winds to be effective in carbon stars. Variability can be simplified to a power law (amplitude proportional to L/T^2), as in other systems. In total, we identify 3026 variable stars (with r.m.s. variability of $\Delta z \gtrsim 0.015$ magnitudes), of which 176 are long-period variables associable with the upper giant branches of the Sgr dSph. We also identify 324 candidate RR Lyræ variables in the the Sgr dSph and 340 in the outer Galactic Bulge.

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The post-common-envelope, binary central star of the planetary nebula Hen 2-11

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We present a detailed photometric study of the central star system of the planetary nebula Hen 2-11, selected for study because of its low-ionisation filaments and bipolar morphology – traits which have been strongly linked with central star binarity. Photometric monitoring with NTT-EFOSC2 reveals a highly irradiated, double-eclipsing, post-common-envelope system with a period of 0.609 d. Modelling of the lightcurve indicates that the nebular progenitor is extremely hot, while the secondary in the system is probably a K-type main sequence star. The chemical composition of the nebula is analysed, showing Hen 2-11 to be a medium-excitation non-Type I nebula. A simple photoionisation model is constructed determining abundance ratios of C/O and N/O which would be consistent with the common-envelope cutting short the AGB evolution of the nebular progenitor. The detection of a post-common-envelope binary system at the heart of Hen 2-11 further strengthens the link between binary progeny and the formation of axisymmetric planetary nebulæ with patterns of low-ionisation filaments, clearly demonstrating their use as morphological indicators of central star binarity.

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Dust origin in late-type dwarf galaxies: ISM growth vs. type II supernovæ

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We re-evaluate the roles of different dust sources in dust production as a function of metallicity in late-type dwarf galaxies, with the goal of understanding the relation between dust content and metallicity. The dust content of late-type dwarf galaxies with episodic star formation is studied with a multicomponent model of dust evolution, which includes dust input from AGB stars, type II SNe and dust growth by accretion of atoms in the ISM. Dust growth in the ISM becomes an important dust source in dwarf galaxies, on the timescale of 0.1 to a few Gyr. It increases the dust-to-gas mass ratio (DGR) during post-burst evolution, unlike type II SNe, which eject grains to the ISM only during starbursts. Before the dust growth in the ISM overtakes the dust production, AGB stars can be major sources of dust in metal-poor dwarf galaxies. Our models reproduce the relation between the DGR and oxygen abundance, derived from observations of a large sample of dwarf galaxies. The steep decrease in the DGR at low metallicities is explained by the relatively low efficiency of dust condensation in stars. The scatter observed at higher metallicities is determined mainly by different metallicities for the transition from stardust- to ISM-growth dominated dust production, depending on the star formation history. In galaxies with episodic star formation, additional dispersion in the DGR is introduced by grain destruction during starbursts, followed by an increase of the dust mass due to dust growth in the ISM during post-burst evolution. We find that the carbon-to-silicate ratio changes dramatically, when the ISM growth becomes the dominant dust source, therefore this ratio can be used as an indicator of the transition. The observed relation of the DGR versus metallicity in dwarf galaxies favours low condensation efficiencies in type SN, together with an increase in the total dust mass by means of dust growth in the ISM.

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Available from arXiv:1401.1675

Search for binary central stars of the SMC PNe

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The Optical Gravitational Lensing Experiment (OGLE), originally designed to search for microlensing events, provides a rich and uniform data set suitable for studying the variability of certain types of objects. We used the OGLE data to study the photometry of central stars of planetary nebulæ (PNe) in the Small Magellanic Cloud (SMC). In particular, we searched for close binary central stars with the aim to constrain the binary fraction and period distribution in the SMC.We also searched for PNe mimics and removed them from the PNe sample. We identified 52 counterparts of PNe in the SMC in the I-band images from the OGLE-II and OGLE-III surveys. We analysed the time-series photometry of the PNe. Spectra of the photometric variables were obtained to constrain the nature of the objects or search for additional evidence for binarity. Eight variables were found. Of these, seven objects are PNe mimics, including one symbiotic star candidate. One close binary central star of PN with a period of 1.15 or 2.31 day was discovered. The obtained binary fraction for the SMC PNe and the observational biases are discussed in terms of the OGLE observations.

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The continuum emission spectrum of Hf 2-2 near the Balmer limit and the ORL versus CEL abundance and temperature discrepancy

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The continuum spectrum of the planetary nebula Hf 2-2 close to the Balmer discontinuity is modeled in the context of the long standing problem of the abundance and temperature discrepancy found when analyzing optical recombination lines and collisionally excited forbidden lines in nebulæ. Models are constructed using single and double Maxwell–Boltzmann distributions as well as κ-distributions for the energies of the free electrons. New results for the necessary continuum and line emission coefficients are presented calculated with κ-distributed energies. The best fit to the observed continuum spectrum is found to be a model comprising two components with dramatically different temperatures and with a Maxwell–Boltzmann distribution of electron energies. On the basis of a χ-squared analysis, this model is strongly favored over a model with κ-distributed electron energies.

Submitted to MNRAS
Available from arXiv:1401.5630

A sensitive search for methanol line emission toward evolved stars

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We present a sensitive search for methanol line emission in evolved stars at 1 cm, aiming to detect, for the first time, methanol masers in this type of objects. Our sample comprised post-AGB stars and young planetary nebulæ (PNe), whose mass-loss processes and circumstellar structures resemble those of young stellar objects (YSOs), where methanol masers are detected. Class I masers were searched for in 73 objects, whereas Class II ones were searched in 16. No detection was obtained. The non-detection of Class I methanol masers indicated that methanol production in dust grains and/or the enhancement of its gas-phase abundance in the shocked regions of evolved objects are not as efficient as in YSOs. We suggest that relatively more evolved PNe might have a better probability of harboring Class II masers.

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Available from arXiv:1401.6913

Multiwavelength modelling the SED of supersoft X-ray sources I. The method and examples

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Radiation of supersoft X-ray sources (SSS) dominates both the supersof X-ray and the far-UV domain. A fraction of their radiation can be reprocessed into the thermal nebular emission, seen in the spectrum from the near-UV to longer wavelengths. In the case of symbiotic X-ray binaries (SyXBs) a strong contribution from their cool giants is indicated in the optical/near-IR. In this paper I introduce a method of multiwavelength modelling the spectral energy distribution

(SED) of SSSs from the supersoft X-rays to the near-IR with the aim to determine the physical parameters of their composite spectra. The method is demonstrated on two extragalactic SSSs, the SyXB RX J0059.1−7505 (LIN 358) in the Small Magellanic Cloud (SMC), RX J0439.8−6809 in the Large Magellanic Cloud (LMC) and two Galactic SSSs, the classical nova RX J2030.5+5237 (V1974 Cyg) during its supersoft phase and the classical symbiotic star RX J1601.6+6648 (AG Dra) during its quiescent phase. The multiwavelength approach overcomes the problem of the mutual dependence between the temperature, luminosity and amount of absorption, which appears when only the X-ray data are fitted. Thus, the method provides an unambiguous solution. It was found that selection of the model (a blackbody or an atmospheric model) is not of crucial importance in fitting the global X-ray/IR SED. The multiwavelength modelling of the SED of SSSs is essential in determining their physical parameters.

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Available from arXiv:1401.1848

Conference Paper

The morpho-kinematics of planetary nebulæ with binary central stars

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It is now clear that a binary formation pathway is responsible for a significant fraction of planetary nebulæ, and this increased sample of known binaries means that we are now in a position to begin to constrain their influence on the formation and evolution of their host nebulæ. Here, we will review current understanding of how binarity influences the resulting nebulæ, based on observations and modelling of both the central binary systems and the planetary nebulæ themselves. We will also highlight the most important test-cases which have proved the most interesting in studying the evolution of binaries into and through the planetary nebula phase.

Oral contribution, published in "Asymmetrical Planetary Nebulæ VI", México
Available from arXiv:1401.4119

Job Adverts

STARKEY post-doc positions at the University of Padova

The University of Padova will soon open several post-doc positions to work on the European Research Council funded project STARKEY. The project aims to provide a solid calibration of the evolution along the TP-AGB phase, using a new generation of detailed stellar models and a wide variety of observations. Potential applicants with experience in the following areas:

- Observations of AGB stars in nearby galaxies
- Hydrodynamical models of stellar envelopes and atmospheres

- Stellar pulsation
- Radiative transfer in dusty envelopes

are encouraged to contact the PI, Paola Marigo (paola.marigo at unipd.it), for more details. The positions will be officially announced and posted in the job register by April 2014. Successful applicants are expected to start working soon after Summer 2014. The positions will be available for two years, renewable for other two.

The STARKEY project includes close collaborations with the colleagues Alessandro Bressan (Trieste), Julianne Dalcanton (Seattle), Léo Girardi (Padova), Martin Groenewegen (Bruxelles), Susanne Höfner (Uppsala), Thomas Lebzelter (Vienna), and Peter Wood (Canberra). Generous travel funds will be provided to foster these collaborations, and to attend major meetings in the field.

In addition, we anticipate that STARKEY will announce a couple of PhD fellowships later this year.

The Department of Physics and Astronomy "Galileo Galilei" in Padova results from the recent fusion of the former Physics Department and Astronomy Department. It runs the bachelor, master and PhD courses in Physics and in Astronomy. The Astronomy division is located next to the INAF Padova Observatory, in a stimulating environment. The University owns many flats in town, that can be rented by the post-docs at convenient rates.

Research Fellow in Astrophysical Spectral Modelling

Applications are invited for a Postdoctoral Research Fellowship position in the area of Astrophysical Spectral Modelling for up to 3 years in the first instance. The post is located in the Centre for Theoretical Atomic, Molecular and Optical Physics (CTAMOP) within the School of Mathematics and Physics, and is a collaborative project between staff in CTAMOP and in the Astrophysics Research Centre (ARC), also located in the School. The successful candidate will work on the use of theoretical atomic physics calculations, generated at Queen's University, to analyse the spectra of a range of astrophysical sources.

Applicants must have a PhD in Astrophysics either awarded or submitted by the time of taking up the post. Experience is essential in the modelling of the spectra of astrophysical sources, as are a number of high quality refereed publications in the research field commensurate with stage of career. Experience in the use of the CLOUDY spectral modelling code, as is some experience in theoretical atomic physics, are desirable.

An application pack for the post, containing further details and guidelines on how to submit your application online, is available at:
http://www.qub.ac.uk/sites/QUBJobVacancies/OtherJobs/ResearchJobs/

under post reference 14/103115.

Informal enquiries may be directed to Prof. Francis Keenan (telephone: +44 2890 973686; email: f.keenan@qub.ac.uk) or Dr. Catherine Ramsbottom (telephone: +44 2890 976047; email: c.ramsbottom@qub.ac.uk).

Salary: £30,728 – £35,597 per annum.

Closing date: Monday, 24 February 2014.

See also http://www.qub.ac.uk/sites/QUBJobVacancies/OtherJobs/ResearchJobs/

Announcement

Cloudy Summer School 2014

The 2014 Cloudy Summer School will be held at Queen's University Belfast over August 18–22 2014. The School will cover observation, theory, and application of CLOUDY to a wide variety of astronomical environments. This includes the theory of diffuse non-LTE matter and quantitative spectroscopy (the science of using spectra to make physical measurements. We will use CLOUDY to simulate such objects as Planetary Nebulæ, H II regions, Active Galactic Nuclei, Starburst galaxies, and the intergalactic medium.

The sessions will consist of a mix of textbook study, using Osterbrock & Ferland, *Astrophysics of Gaseous Nebulæ and Active Galactic Nuclei*, application of the spectral-simulation code CLOUDY to a variety of astrophysical problems, and projects organized by the participants. No prior experience with CLOUDY is assumed.

See also http://cloud9.pa.uky.edu/∼gary/cloudy/CloudySummerSchool/