THE AGB NEWSLETTER

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

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

No. 233 — 4 December 2016

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

Editors: Jacco van Loon, Ambra Nanni and Albert Zijlstra

Editorial

Dear Colleagues,

It is a pleasure to present you the 233rd issue of the AGB Newsletter. Besides many interesting new journal papers and conference proceedings contributions there is an announcement of a "Thinkshop" in Potsdam on the topic of magnetic fields in stars, as well as a job opening for a postdoctoral researcher in Spain. Nature Astronomy also advertises again the launch of this new journal.

Last month's Food for Thought, "Can a convection cell become as large as the entire star?" generated some interest. Elizabeth Griffin responded: "Very probably, and may already do so, when it is called a recurrent nova or something similar." She also suggested this month's Food for Thought (see below). Wolfgang Steffen responded: "I have no idea whether a convection cell can be as large as the whole star, but for some time I have been wondering whether large convection cells can generate structure in the dense winds and hence can potentially contribute to the large scale structure of a planetary nebula. Possibly the time scales of the convection are too small, but who knows. How about resonances (with binary or planetary orbit periods)? Could resonances generate regular patterns that contribute to the formation of multipolar patterns in the PNe?" Indeed, one of the editors (JvL), when coming up with the Food for Thought statement, had been thinking of a mechanism triggering the ejection of a final shell of matter that would go on to form a planetary nebula in the first place.

The next issue is planned to be distributed around the 3rd of January, 2017. We wish you a Merry Christmas and a Happy New Year!

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

Food for Thought

This month's thought-provoking statement is:

"Is there any reason, apart from anthropogenic convenience, why two stars should be identical?"

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

Refereed Journal Papers

The unstable fate of the planet orbiting the A-star in the HD 131399 triple stellar system

Dimitri Veras[1], *Alexander J. Mustill*[2] *and Boris T. Gänsicke*[1]

[1]Department of Physics, University of Warwick, Coventry CV4 7AL, UK

[2]Lund Observatory, Department of Astronomy and Theoretical Physics, Lund University, Box 43, SE-221 00 Lund, Sweden

Validated planet candidates need not lie on long-term stable orbits, and instability triggered by post-main-sequence stellar evolution can generate architectures which transport rocky material to white dwarfs, polluting them. The giant planet HD 131399Ab orbits its parent A star at a projected separation of about 50–100 au. The host star, HD 131399A, is part of a hierarchical triple with HD 131399BC being a close binary separated by a few hundred au from the A star. Here, we determine the fate of this system, and find that (i) stability along the main sequence is achieved only for a favourable choice of parameters within the errors, and (ii) even for this choice, in almost every instance the planet is ejected during the transition between the giant branch and white dwarf phases of HD 131399A. This result provides an example of both how the free-floating planet population may be enhanced by similar systems, and how instability can manifest in the polluted white dwarf progenitor population.

Accepted for publication in MNRAS
Available from http://arxiv.org/abs/1611.00007

A mid-IR interferometric survey with MIDI/VLTI: resolving the second-generation protoplanetary disks around post-AGB binaries

M. Hillen, M.[1], *H. Van Winckel, H.*[1], *J. Menu*[1], *R. Manick*[1], *H. Debosscher*[1], *M. Min*[2,3], *J.-W. De Wit*[4], *T. Verhoelst*[5], *D. Kamath*[1] *and L.B.F.M. Waters*[3]

[1]Instituut voor Sterrenkunde, K.U. Leuven, Belgium

[2]Anton Pannekoek Institute for Astronomy. University of Amsterdam, The Netherlands

[3]SRON, Utrecht, The Netherlands

[4]European Southern Observatory, Santiago, Chile

[5]Belgian Institute for Space Aeronomy, Belgium

We present a mid-IR interferometric survey of the circumstellar environment of a specific class of post-Asymptotic Giant Branch (post-AGB) binaries. For this class the presence of a compact dusty disk has been postulated on the basis of various spatially unresolved measurements. Our interferometric survey was performed with the MIDI instrument on the VLTI. In total 19 different systems were observed using variable baseline configurations. Combining all the visibilities at a single wavelength at 10.7 μm, we fitted two parametric models to the data: a uniform disk (UD) and a ring model mimicking a temperature gradient. We compared our observables of the whole sample, with synthetic data computed from a grid of radiative transfer models of passively irradiated disks in hydrostatic equilibrium. These models are computed with a Monte Carlo code that has been widely applied to describe the structure of protoplanetary disks around young stellar objects (YSO). The spatially resolved observations show that the majority of our targets cluster closely together in the distance-independent size–colour diagram, and have extremely compact N-band emission regions. The typical uniform disk diameter of the N-band emission region is about 40 mas which corresponds to a typical brightness temperature of 400–600 K. The resolved objects display very similar characteristics in the interferometric observables and in the spectral energy distributions. Therefore, the physical properties of the disks around our targets must be similar. The grid of protoplanetary disk models covers very well the observed objects. Much like for young stars, the spatially resolved N-band emission region is determined by the hot inner rim of the disk. Continued comparisons between post-AGB and protoplanetary disks will help to understand grain growth and disk evolution processes,

Accepted for publication in Astronomy and Astrophysics
Available from http://arxiv.org/abs/1610.09930

The impact of the revised $^{17}O(p,\alpha)^{14}N$ reaction rate on ^{17}O stellar abundances and yields

O. Straniero[1] *et al.*

[1]INAF, Osservatorio Astronomico di Teramo, Italy

Context: Material processed by the CNO cycle in stellar interiors is enriched in ^{17}O. When mixing processes from the stellar surface reach these layers, as occurs when stars become red giants and undergo the first dredge up, the abundance of ^{17}O increases. Such an occurrence explains the drop of the $^{16}O/^{17}O$ observed in RGB stars with mass larger than 1.5 $M_{\odot}$. As a consequence, the interstellar medium is continuously polluted by the wind of evolved stars enriched in ^{17}O.
Aims: Recently, the Laboratory for Underground Nuclear Astrophysics (LUNA) collaboration released an improved rate of the $^{17}O(p,\alpha)^{14}N$ reaction. In this paper we discuss the impact that the revised rate has on the $^{16}O/^{17}O$ ratio at the stellar surface and on ^{17}O stellar yields.
Methods: We computed stellar models of initial mass between 1 and 20 $M_{\odot}$ and compared the results obtained by adopting the revised rate of the $^{17}O(p,\alpha)^{14}N$ to those obtained using previous rates.
Results: The post-first dredge up $^{16}O/^{17}O$ ratios are about 20% larger than previously obtained. Negligible variations are found in the case of the second and the third dredge up. In spite of the larger $^{17}O(p,\alpha)^{14}N$ rate, we confirm previous claims that an extra-mixing process on the red giant branch, commonly invoked to explain the low carbon isotopic ratio observed in bright low-mass giant stars, marginally affects the $^{16}O/^{17}O$ ratio. Possible effects on AGB extra-mixing episodes are also discussed. As a whole, a substantial reduction of ^{17}O stellar yields is found. In particular, the net yield of stars with mass ranging between 2 and 20 $M_{\odot}$ is 15 to 40% smaller than previously estimated.
Conclusions: The revision of the $^{17}O(p,\alpha)^{14}N$ rate has a major impact on the interpretation of the $^{16}O/^{17}O$ observed in evolved giants, in stardust grains and on the ^{17}O stellar yields.

Accepted for publication in Astronomy and Astrophysics
Available from http://arxiv.org/abs/1611.00632

New in the optical spectrum and kinematic state of the atmosphere of the variable V1027 Cyg (= IRAS 20004+2955)

V.G. Klochkova[1], *V.E. Panchuk*[1] *and N.S. Tavolganskaya*[1]

[1]Special Astrophysical Observatory RAS, Nizhnij Arkhyz, 369167 Russia

Based on high-resolution spectroscopy performed with the NES échelle spectrograph of the 6-m telescope, we have studied the peculiarities of the spectrum and the velocity field in the atmosphere and envelope of the cool supergiant V1027 Cyg, the optical counterpart of the infrared source IRAS 20004+2955. For the first time, a splitting of the cores of strong absorptions of metals and their ions (Si II, Ni I, Ti I, Ti II, Sc II, Cr I, Fe I, Fe II, Ba II) has been detected in the stellar spectrum. The properties and the behavior of their profiles are seems very strange. The broad profile of these lines contain a stable weak emission in the core whose position may be considered as the systematic velocity $v_{\rm sys}$ = 5.5 km s^{-1}. Small radial velocity variations with an amplitude of 5–6 km s^{-1} due to pulsations have been revealed by symmetric low- and moderate-intensity absorptions. A long-wavelength shift of the Hα profile due to line core distortion is observed in the stellar spectrum. Numerous weak CN molecular lines and the K I 7696 Å line with a P Cyg profile have been identified in the red spectral region. The coincidence of the radial velocities measured from symmetric metal absorptions and CN lines suggests that the CN spectrum is formed in the stellar atmosphere. We have also identified numerous diffuse interstellar bands (DIBs) whose positions in the spectrum, $v_{\rm r(DIBs)} = -12.0$ km s^{-1}, correspond to the velocity of the interstellar medium in the Local arm of the Galaxy.

Accepted for publication in Astronomy Letters, vol. 42, No. 12 (2016)
Available from http://arxiv.org/abs/1611.00475

Runaway dwarf carbon stars as candidate supernova ejecta

Kathryn A. Plant[1], *Bruce Margon*[1], *Puragra Guhathakurta*[1], *Emily C. Cunningham*[1], *Elisa Toloba*[1] *and Jeffrey A. Munn*[2]

[1]UCSC, USA

[2]USNO, USA

The dwarf carbon (dC) star SDSS J112801.67+004034.6 has an unusually high radial velocity, 531 ± 4 km s^{-1}. We present proper motion and new spectroscopic observations which imply a large Galactic rest frame velocity, 425 ± 9 km s^{-1}. Several other SDSS dC stars are also inferred to have very high galactocentric velocities, again each based on both high heliocentric radial velocity and also confidently detected proper motions. Extreme velocities and the presence of C_2 bands in the spectra of dwarf stars are both rare. Passage near the Galactic center can accelerate stars to such extreme velocities, but the large orbital angular momentum of SDSS J1128 precludes this explanation. Ejection from a supernova in a binary system or disruption of a binary by other stars are possibilities, particularly as dC stars are thought to obtain their photospheric C_2 via mass transfer from an evolved companion.

Accepted for publication in Astrophysical Journal

Available from http://arxiv.org/abs/1611.01185

Missing Fe: hydrogenated iron nanoparticles

G. Bilalbegović[1], *A. Maksimović*[2] *and V. Mohaček-Grošev*[2]

[1]Department of Physics, Faculty of science, University of , Bijenička 32, 10000 Zagreb, Croatia

[2]Center of Excellence for Advanced Materials and Sensing Devices, Rudjer Bošković Institute, Bijenička 54, 10000 Zagreb, Croatia

Although it was found that the FeH lines exist in the spectra of some stars, none of the spectral features in the ISM have been assigned to this molecule. We suggest that iron atoms interact with hydrogen and produce Fe–H nanoparticles which sometimes contain many H atoms. We calculate infrared spectra of hydrogenated iron nanoparticles using density functional theory methods and find broad, overlapping bands. Desorption of H_2 could induce spinning of these small Fe–H dust grains. Some of hydrogenated iron nanoparticles posses magnetic and electric moments and should interact with electromagnetic fields in the ISM. Fe_nH_m nanoparticles could contribute to the polarization of the ISM and the anomalous microwave emission. We discuss the conditions required to form FeH and Fe_nH_m in the ISM.

Accepted for publication in MNRAS Letters

Available from http://arxiv.org/abs/1611.00309

and from http://mnrasl.oxfordjournals.org/content/early/2016/11/04/mnrasl.slw226.abstract

Dipole modes with depressed amplitudes in red giants are mixed modes

B. Mosser[1], *K. Belkacem*[1], *C. Pinçon*[1], *M. Takata*[3], *M. Vrad*[3], *C. Barban*[1], *M.-J. Goupil*[1], *T. Kallinger*[4] *and R. Samadi*[1]

[1]LESIA, Observatoire de Paris, PSL Research University, CNRS, Université Pierre et Marie Curie, Université Paris Diderot, 92195 Meudon, France

[2]Department of Astronomy, School of Science, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan

[3]Instituto de Astrofísica e Ciências do Espaço, Universidade do Porto, CAUP, Rua das Estrelas, 4150-762 Porto, Portugal

[4]Institute of Astrophysics, University of Vienna, Türkenschanzstraße 17, Vienna 1180, Austria

Context: Seismic observations with the space-borne *Kepler* mission have shown that a number of evolved stars exhibit low-amplitude dipole modes, which is referred to as depressed modes. Recently, these low amplitudes have been attributed to the presence of a strong magnetic field in the stellar core of those stars. Subsequently, and based on this scenario, the prevalence of high magnetic fields in evolved stars has been inferred. It should be noted, however, that

this conclusion remains indirect.
Aims: We intend to study the properties of mode depression in evolved stars, which is a necessary condition before reaching conclusions about the physical nature of the mechanism responsible for the reduction of the dipole mode amplitudes.
Methods: We perform a thorough characterization of the global seismic parameters of depressed dipole modes and show that these modes have a mixed character. The observation of stars showing dipole mixed modes that are depressed is especially useful for deriving model-independent conclusions on the dipole mode damping. We use a simple model to explain how mode visibilities are connected to the extra damping seen in depressed modes.
Results: Observations prove that depressed dipole modes in red giants are not pure pressure modes but mixed modes. This result, observed in more than 90% of the bright stars ($m_{\mathrm{V}} < 11$ mag), invalidates the hypothesis that depressed dipole modes result from the suppression of the oscillation in the radiative core of the stars. Observations also show that, except for visibility, seismic properties of the stars with depressed modes are equivalent to those of normal stars. The measurement of the extra damping that is responsible for the reduction of mode amplitudes, without any prior on its physical nature, potentially provides an efficient tool for elucidating the mechanism responsible for the mode depression.
Conclusions: The mixed nature of the depressed modes in red giants and their unperturbed global seismic parameters carry strong constraints on the physical mechanism responsible for the damping of the oscillation in the core. This mechanism is able to damp the oscillation in the core but cannot fully suppress it. Moreover, it cannot modify the radiative cavity probed by the gravity component of the mixed modes. The recent mechanism involving high magnetic fields proposed for explaining depressed modes is not compliant with the observations and cannot be used to infer the strength and prevalence of high magnetic fields in red giants.

Accepted for publication in A&A
Available from http://arxiv.org/abs/1610.03872

Do water fountain jets really indicate the onset of the morphological metamorphosis of circumstellar envelopes?

Bosco H.K. Yung[1,2], *Jun-ichi Nakashima*[3,2], *Chih-Hao Hsia*[5,4,2] *and Hiroshi Imai*[6]

[1]Nicolaus Copernicus Astronomical Centre, Poland
[2]Dept. of Physics, The University of Hong Kong, Hong Kong, China
[3]Dept. of Astronomy and Geodesy, Ural Federal University, Russia
[4]Laboratory for Space Research, The University of Hong Kong, Hong Kong, China
[5]Space Science Insitute, Macau University of Science and Technology, Macau, China
[6]Graduate School of Science and Engineering, Kagoshima University, Japan

The small-scale bipolar jets having short dynamical ages from "water fountain (WF)" sources are regarded as an indication of the onset of circumstellar envelope morphological metamorphosis of intermediate-mass stars. Such process usually happens at the end of the asymptotic giant branch (AGB) phase. However, recent studies found that WFs could be AGB stars or even early planetary nebulæ. This fact prompted the idea that WFs may not necessarily be objects at the beginning of the morphological transition process. In the present work, we show that WFs could have different envelope morphologies by studying their spectral energy distribution profiles. Some WFs have spherical envelopes that resembles usual AGB stars, while others have aspherical envelopes which are more common to post-AGB stars. The results imply that WFs may not represent the earliest stage of the morphological metamorphosis. We further argue that the dynamical age of a WF jet, which can be calculated from maser proper motions, may not be the real age of the jet. The dynamical age cannot be used to justify the moment when the envelope begins to become aspherical, nor to tell the concrete evolutionary status of the object. A WF jet could be the innermost part of a larger well-developed jet, which is not necessarily a young jet.

Accepted for publication in MNRAS
Available from http://arxiv.org/abs/1611.03306

Emission-line stars in M 31 from the SPLASH and PHAT surveys

Laura J. Prichard[1], *Puragra Guhathakurta*[2], *Katherine M. Hamren*[2], *Julianne J. Dalcanton*[3], *Claire E. Dorman*[2], *Anil C. Seth*[4], *Benjamin F. Williams*[3], *Gabriel A. Damon*[5], *Anita Ilango*[6] and *Megha Ilango*[6]

[1]Sub-department of Astrophysics, Department of Physics, University of Oxford, Denys Wilkinson Building, Keble Road, Oxford OX1 3RH, UK

[2]UCO/Lick Observatory, University of California Santa Cruz, 1156 High Street, Santa Cruz, CA 95064, USA

[3]Department of Astronomy, Box 351580, University of Washington, Seattle, WA 98195, USA

[4]Department of Physics & Astronomy, University of Utah, Salt Lake City, UT 84112, USA

[5]Santa Cruz High School, 415 Walnut Avenue, Santa Cruz, CA 95060, USA

[6]Cupertino High School, 10100 Finch Avenue, Cupertino, CA 95014, USA

We present a sample of 224 stars that emit Hα| (Hα stars) in the Andromeda galaxy (M 31). The stars were selected from $\sim$ 5000 spectra, collected as part of the Spectroscopic and Photometric Landscape of Andromeda's Stellar Halo survey using Keck II/DEIMOS. We used six-filter *Hubble* Space Telescope photometry from the Panchromatic *Hubble* Andromeda Treasury survey to classify and investigate the properties of the Hα stars. We identified five distinct categories of Hα star: B-type main sequence (MS) stars, 'transitioning'-MS (T-MS) stars, red core He burning (RHeB) stars, non-C-rich asymptotic giant branch (AGB) stars, and C-rich AGB stars. We found $\sim$ 12 per cent of B-type stars exhibit Hα emission (Be stars). The frequency of Be to all B stars is known to vary with the metallicity of their environment. Comparing this proportion of Be stars with other environments around the Local Group, the result could indicate that M 31 is more metal rich than the Milky Way. We predict that the 17 T-MS Hα stars are Be stars evolving off the MS with fading Hα emission. We separated RHeB from AGB Hα stars. We conclude that the 61 RHeB and AGB stars are likely to be Long Period Variables. We found that $\sim$ 14 per cent of C-rich AGB stars (C stars) emit Hα, which is an upper limit for the ratio of C-rich Miras to C stars. This catalogue of Hα stars will be useful to constrain stellar evolutionary models, calibrate distance indicators for intermediate age populations, and investigate the properties of M 31.

Accepted for publication in MNRAS
Available from http://arxiv.org/abs/1611.05043

Studies of the long secondary periods in pulsating red giants. II. Lower-luminosity stars

John R. Percy[1] and *Henry Leung*[1]

[1]Department of Astronomy and Astrophysics, University of Toronto, Toronto ON, M5S 3H4, Canada

We have used AAVSO visual and photoelectric V data, and the AAVSO time-series package VSTAR and the Lomb–Scargle time-series algorithm to determine improved pulsation periods, "long secondary periods" (LSPs) and their amplitudes in 51 shorter-period pulsating red giants in the AAVSO photoelectric photometry program, and in the AAVSO LPV (long period variable) binocular program. As is well known, radial pulsation becomes detectable in red giants at about spectral type M0, with periods of about 20 days. We find that the LSP phenomenon is also first detectable at about M0. Pulsation and LSP amplitudes increase from near zero to about 0.1 at periods of 100 days. At longer periods, the pulsation amplitudes continue to increase, but the LSP amplitudes are generally between 0.1 and 0.2 on average. The ratios of the LSP to the pulsation period cluster around 5 and 10, presumably depending on whether the pulsation period is the fundamental or the first overtone. The pulsation and LSP phase curves are generally close to sinusoidal, except when the amplitude is small, in which case they may be distorted by observational scatter or, in the case of the LSP amplitude, by the pulsational variability. As with longer-period stars, the LSP amplitude increases and decreases by a factor of two or more, for unknown reasons, on a median time scale of about 20 LSPs. The LSP phenomenon is thus present and similar in radially pulsating red giants of all periods. Its cause remains unknown.

Submitted to JAAVSO
Available from http://arxiv.org/abs/1611.03334

Search for aluminium monoxide in the winds of oxygen-rich AGB stars

E. De Beck[1], *L. Decin*[2,3], *S. Ramstedt*[4], *H. Olofsson*[1], *K.M. Menten*[5], *N.A. Patel*[6] *and W.H.T. Vlemmings*[1]

[1]Department for Earth and Space Sciences, Chalmers University of Technology, Onsala Space Observatory, Sweden

[2]Instituut voor Sterrenkunde, Departement Natuurkunde en Sterrenkunde, Celestijnenlaan 200D, 3001 Heverlee, Belgium

[3]Sterrenkundig Instituut Anton Pannekoek, University of Amsterdam, Science Park 904, 1098 Amsterdam, The Netherlands

[4]Department of Physics and Astronomy, Uppsala University, Box 516, 75120 Uppsala, Sweden

[5]Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, 53121 Bonn, Germany

[6]Harvard–Smithsonian Center for Astrophysics, 60 Garden Street, MS78, Cambridge, MA 02138, USA

Aluminium monoxide, AlO, is likely efficiently depleted from the gas around oxygen-rich evolved stars to form alumina (Al_2O_3) clusters and dust seeds. The presence of AlO gas in the extended atmospheres of evolved stars has been derived from optical spectroscopy. More recently, AlO gas was also detected at long wavelengths around the supergiant VY CMa and the oxygen-rich asymptotic giant branch star o Cet (Mira A). The central role aluminium might play in dust formation and wind driving, in combination with these first detections of AlO at long wavelengths, shows the need for a wider search for this molecule in the winds of evolved stars.

The detection at long wavelengths of emission in rotational transitions of AlO towards asymptotic giant branch stars can help constrain the presence and location of AlO gas in the outflows and ultimately also the efficiency of the depletion process.

In search of AlO, we mined data obtained with APEX, the IRAM 30-m telescope, *Herschel*/HIFI, SMA, and ALMA, which were primarily aimed at studying other species around AGB stars. We report here on observations of AlO towards a sample of eight oxygen-rich asymptotic giant branch stars in different rotational transitions, up to seven for some stars.

We present definite detections of one rotational transition of AlO for o Cet and R Aqr, and tentative detections of one transition for R Dor and o Cet and two transitions for IK Tau and W Hya. The presented spectra of WX Psc, R Cas, and TX Cam show no signature of AlO. For o Cet, R Aqr, and IK Tau, we find that the AlO ($N = 9$–8) emission likely traces the inner parts of the wind, out to only a few tens of au, where the gas has not yet been accelerated to its terminal velocity. This is in agreement with recently published results from a detailed study on o Cet.

The conclusive detections of AlO emission in the case of o Cet and R Aqr confirm the presence of AlO in the gas phase in outflows of asymptotic giant branch stars. The tentative detections further support this. Since most of the observations presented in this study were obtained with stronger emission from other species than AlO in mind, observations with higher sensitivity in combination with high angular resolution will improve our understanding of the presence and behaviour of AlO. From the current data sets we cannot firmly conclude whether there is a direct correlation between the wind properties and the detection rate of AlO emission. We hope that this study can serve as a stimulus to perform sample studies in search of AlO in oxygen-rich outflows.

Accepted for publication in Astronomy & Astrophysics
Available from http://arxiv.org/abs/1611.05409
and from http://www.aanda.org/articles/aa/pdf/forth/aa28928-16.pdf

Models for sixty double-lined binaries containing giants

Peter P. Eggleton[1] *and Kadri Yakut*[2]

[1]Lawrence Livermore National Laboratory, 7000 East Ave, Livermore, CA94551, USA

[2]Department of Astronomy & Space Sciences, University of Ege , 35100, Bornova–İzmir, Turkey

The observed masses, radii and temperatures of 60 medium- to long-period binaries, most of which contain a cool, evolved star and a hotter less-evolved one, are compared with theoretical models which include (a) core convective overshooting, (b)mass loss, possibly driven by dynamo action as in RS CVn binaries, and (c) tidal friction, including its effect on orbital period through magnetic braking. A reasonable fit is found in about 42 cases, but in 11 other cases the primaries appear to have lost either more mass or less mass than the models predict, and in 4 others the orbit is predicted to be either more or less circular than observed. Of the remaining 3 systems, two (γ Per and HR 8242) have a markedly 'over-evolved' secondary, our explanation being that the primary component is the merged remnant of a former short-period sub-binary in a former triple system. The last system (V695 Cyg) defies any agreement at present. Mention is also made of three other systems (V643 Ori, OW Gem and V453 Cep), which are relevant to our discussion.

Submitted to MNRAS
Available from http://arxiv.org/abs/1611.05041

Origins of carbon enhanced metal poor stars

Mahavir Sharma[1], *Tom Theuns*[1], *Carlos Frenk*[1] *and Ryan Cooke*[1]

[1]Institute for Computational Cosmology, Department of Physics, Durham University, UK

We investigate the nature of carbon-enhanced metal poor (CEMP) stars in Milky Way (MW) analogues selected from the EAGLE cosmological hydrodynamical simulation. The stellar evolution model in EAGLE includes the physics of enrichment by asymptotic giant branch (AGB) stars, winds from massive stars, and type I and type II supernovæ (SNe). In the simulation, star formation in young MW progenitors is bursty due to efficient stellar feedback, which causes poor metal mixing leading to the formation of CEMP stars with extreme abundance patterns. In this scenario, two classes of CEMP stars emerge: those mostly enriched by low-metallicity type II SNe with low Fe yields that drive galactic outflows, and those mostly enriched by AGB stars when a gas-poor progenitor accretes pristine gas. The first class resembles CEMP-no stars with high [C/Fe] and low [C/O], the second class resembles CEMP-s stars overabundant in s-process elements and high values of [C/O]. This scenario explains several trends seen in data: (i) the increase in the scatter and median of [C/O] at low and decreasing [O/H], (ii) the trend of stars with very low [Fe/H] or [C/H] to be of type CEMP-no, and (iii) the reduction in the scatter of [α/Fe] with atomic number in metal poor stars. In this scenario, CEMP stars were enriched by the first few generations of stars and supernovae that enabled hydrogen reionization in the early Universe.

Submitted to MNRAS
Available from http://arxiv.org/abs/1611.03868

DUSTiNGS III: Distribution of intermediate-age and old stellar populations in disks and outer extremities of dwarf galaxies

Kristen B.W. McQuinn[1,2], *Martha L. Boyer*[3,4], *Mallory B. Mitchell*[2], *Evan D. Skillman*[2], *R.D. Gehrz*[2], *Martin A.T. Groenewegen*[5], *Iain McDonald*[6], *G.C. Sloan*[7,8,9], *Jacco Th. van Loon*[10], *Patricia A. Whitelock*[11,12] *and Albert A. Zijlstra*[6]

[1]University of Texas at Austin, McDonald Observatory, 2515 Speedway, Stop C1402, Austin, Texas 78712, USA

[2]Minnesota Institute for Astrophysics, School of Physics and Astronomy, 116 Church Street, S.E., University of Minnesota, Minneapolis, MN 55455, USA

[3]Observational Cosmology Lab, Code 664, NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA

[4]Department of Astronomy, University of Maryland, College Park, MD 20742, USA

[5]Koninklijke Sterrenwacht van België, Ringlaan 3, B-1180 Brussels, Belgium

[6]Jodrell Bank Centre for Astrophysics, School of Physics and Astronomy, University of Manchester, Manchester, M13 9PL, UK

[7]Cornell Center for Astrophysics & Planetary Science, Cornell Univ., Ithaca, NY 14853-6801, USA

[8]Department of Physics and Astronomy, University of North Carolina, Chapel Hill, NC 27599-3255, USA

[9]Space Telescope Science Institute, 3700 San Martin Dr., Baltimore, MD 21218, USA

[10]Astrophysics Group, Lennard-Jones Laboratories, Keele University, Staffordshire ST5 5BG, UK

[11]Astronomy Department, University of Cape Town, 7701 Rondebosch, South Africa

[12]South African Astronomical Observatory (SAAO), P.O. Box 9, 7935 Observatory, South Africa

We have traced the spatial distributions of intermediate-age and old stars in nine dwarf galaxies in the distant parts of the Local Group, using multi-epoch 3.6 and 4.5 μm data from the DUST in Nearby Galaxies with *Spitzer* (DUSTiNGS) survey. Using complementary optical imaging from the *Hubble* Space Telescope, we identify the tip of the red giant branch (TRGB) in the 3.6 μm photometry, separating thermally-pulsating asymptotic giant branch (TP-AGB) stars

from the larger red giant branch (RGB) populations. Unlike the constant TRGB in the I-band, at 3.6 μm the TRGB magnitude varies by ~ 0.7 mag, making it unreliable as a distance indicator. The intermediate-age and old stars are well mixed in two-thirds of the sample with no evidence of a gradient in the ratio of the intermediate-age to old stellar populations outside the central $\sim 1'$–$2'$. Variable AGB stars are detected in the outer extremities of the galaxies, indicating that chemical enrichment from these dust-producing stars may occur in the outer regions of galaxies with some frequency. Theories of structure formation in dwarf galaxies must account for the lack of radial gradients in intermediate-age populations and the presence of these stars in the outer extremities of dwarfs. Finally, we identify unique features in individual galaxies, such as extended tidal features in Sex A and Sag DIG and a central concentration of AGB stars in the inner regions of NGC 185 and NGC 147.

Accepted for publication in ApJ
Available from http://arxiv.org/abs/1611.05044

The puzzle of the CNO isotope ratios in AGB carbon stars

Carlos Abia [1], Rubén P. Hedrosa[2], Inma Domínguez[1] and Oscar Straniero[3]

[1]Dpto. Física Téorica y del Cosmos, Universidad de Granada, Granada, Spain
[2]Observatorio de Calar Alto, Gergal, Almería, Spain
[3]INAF, Osservatorio Astronomico di Collurania, 64100 Teramo, Italy

The abundance ratios of the main isotopes of carbon, nitrogen and oxygen are modified by the CNO-cycle in the stellar interiors. When the different dredge-up events mix the burning material with the envelope, valuable information on the nucleosynthesis and mixing processes can be extracted by measuring these isotope ratios. Previous determinations of the oxygen isotopic ratios in asymptotic giant branch (AGB) carbon stars were at odds with the existing theoretical predictions. We aim to redetermine the oxygen ratios in these stars using new spectral analysis tools and further develop discussions on the carbon and nitrogen isotopic ratios in order to elucidate this problem. Oxygen isotopic ratios were derived from spectra in the K-band in a sample of galactic AGB carbon stars of different spectral types and near solar metallicity. Synthetic spectra calculated in local thermodynamic equillibrium (LTE) with spherical carbon-rich atmosphere models and updated molecular line lists were used. The CNO isotope ratios derived in a homogeneous way, were compared with theoretical predictions for low-mass (1.5–3 $M_\odot$) AGB stars computed with the FUNS code assuming extra mixing both during the RGB and AGB phases. For most of the stars the $^{16}O/^{17}O/^{18}O$ ratios derived are in good agreement with theoretical predictions confirming that, for AGB stars, are established using the values reached after the first dredge-up (FDU) according to the initial stellar mass. This fact, as far as the oxygen isotopic ratios are concerned, leaves little space for the operation of any extra mixing mechanism during the AGB phase. Nevertheless, for a few stars with large $^{16}O/^{17}O/^{18}O$, the operation of such a mechanism might be required, although their observed $^{12}C/^{13}C$ and $^{14}N/^{15}N$ ratios would be difficult to reconcile within this scenario. Furthermore, J-type stars tend to have lower $^{16}O/^{17}O$ ratios than the normal carbon stars, as already indicated in previous studies. Excluding these peculiar stars, AGB carbon stars occupy the same region as pre-solar type I oxide grains in a $^{17}O/^{16}O$ vs. $^{18}O/^{16}O$ diagram, showing little spread. This reinforces the idea that these grains were probably formed in low-mass stars during the previous O-rich phases.

Accepted for publication in Astronomy & Astrophysics
Available from http://arxiv.org/abs/1611.06400

H_2 in low-ionization structures of planetary nebulæ

Akras Stavros[1], Denise R. Gonçalves[1] and Gerardo Ramos-Larios[2]

[1]Observatório do Valongo, Universidade Federal do Rio de Janeiro, Ladeira Pedro Antonio 43, 20080-090, Rio de Janeiro, Brasil
[2]Instituto de Astronomía y Meteorología, Av. Vallarta No. 2602. Col. Arcos Vallarta, CP 44130, Guadalajara, Jalisco, México

We report the detection of near-IR H_2 emission from the low-ionization structures (knots) in two planetary nebulæ. The deepest ever high-angular-resolution H_2 1–0 S(1) at 2.122 μm, H_2 2–1 S(1) at 2.248 μm and Brγ images of K 4-47 and NGC 7662, obtained using the Near InfraRed Imager and Spectrometer (NIRI) at Gemini-North, are analyzed

here. K 4-47 reveals a remarkable highly collimated bipolar structure not only in the optical but also in the molecular hydrogen emission. The H_2 emission emanates from the walls of the bipolar outflows and also from the pair of knots at the tip of the outflows. The H_2 1–0 S(1)/2–1 S(1) line ratio ranges from ~ 7 to ~ 10 suggesting the presence of shock interactions. Our findings can be explained by the interaction of a jet/bullet ejected from the central star with the surrounding asymptotic giant branch material. The strongest H_2 line, $v = 1$–0 S(1), is also detected in several low-ionization knots located at the periphery of the elliptical planetary nebula NGC 7662, but only four of these knots are detected in the H_2 $v = 2$–1 S(1) line. These four knots exhibit an H_2 line ratio between 2 and 3.5, which suggests that the emission is caused by the UV ionizing flux of the central star. Our data confirms the presence of H_2 gas in both fast- and slow-moving low-ionization knots, which has only been confirmed before in the nearby Helix nebula and Hu 1-2. Overall, the low-ionization structures of planetary nebulæ are found to share similar traits to photodissociation regions.

Accepted for publication in MNRAS
Available from http://arxiv.org/abs/1611.06578

Clumpy dust clouds and extended atmosphere of the AGB star W Hya revealed with VLT/SPHERE-ZIMPOL and VLTI/AMBER II. Time variations between pre-maximum and minimum light

Keiichi Ohnaka[1], *Gerd Weigelt*[2] *and Karl-Heinz Hofmann*[2]

[1]Universidad Católica del Norte, Antofagasta, Chile
[2]Max-Planck-Institut für Radioastronomie, Bonn, Germany

Our recent visible polarimetric images of the well-studied AGB star W Hya taken at pre-maximum light (phase 0.92) with VLT/SPHERE-ZIMPOL have revealed clumpy dust clouds close to the star at $\sim 2\ R_\star$. We present second-epoch SPHERE-ZIMPOL observations of W Hya at minimum light (phase 0.54) in the continuum (645, 748, and 820 nm), in the Hα line (656.3 nm), and in the TiO band (717 nm) as well as high-spectral resolution long-baseline interferometric observations in 2.3 μm CO lines with the AMBER instrument at the Very Large Telescope Interferometer (VLTI). The high-spatial resolution polarimetric images have allowed us to detect clear time variations in the clumpy dust clouds as close as 34–50 mas (1.4–2.0 $R_\star$) to the star. We detected the formation of a new dust cloud and the disappearance of one of the dust clouds detected at the first epoch. The Hα and TiO emission extend to ~ 150 mas ($\sim 6\ R_\star$), and the Hα images reveal time variations. The degree of linear polarization is higher at minimum light (13–18%) than that at pre-maximum light. The power-law-type limb-darkened disk fit to the AMBER data in the continuum results in a limb-darkened disk diameter of 49.1 ± 1.5 mas and a limb-darkening parameter of 1.16 ± 0.49, indicating that the atmosphere is more extended with weaker limb-darkening compared to pre-maximum light. Our Monte Carlo radiative transfer modeling suggests the predominance of small (0.1 μm) grains of Al_2O_3, Mg_2SiO_4, and $MgSiO_3$ at minimum light, in marked contrast to the predominance of large (0.5 μm) grains at pre-maximum light. The variability phase dependence of the grain size implies that small grains might just have started to form at minimum light in the wake of a shock, while the pre-maximum light phase might have corresponded to the phase of efficient grain growth.

Accepted for publication in Astronomy and Astrophysics
Available from http://arxiv.org/abs/1611.04622

^{22}Ne and ^{23}Na ejecta from intermediate-mass stars: The impact of the new LUNA rate for ^{22}Ne(p,γ)^{23}Na

A. Slemer[1], *P. Marigo*[1,2], *D. Piatti*[1,2] *and the LUNA Collaboration*

[1]University of Padova, Italy
[2]INFN of Padova, Italy

We investigate the impact of the new LUNA rate for the nuclear reaction ^{22}Ne(p,γ)^{23}Na on the chemical ejecta of intermediate-mass stars, with particular focus on the thermally-pulsing asymptotic giant branch (TP-AGB) stars that experience hot-bottom burning. To this aim we use the PARSEC and COLIBRI codes to compute the complete evolution, from the pre-main sequence up to the termination of the TP-AGB phase, of a set of stellar models with initial masses in the range 3.0–6.0 $M_{\odot}$, and metallicities $Z_i = 0.0005$, 0.006, and 0.014. We find that the new LUNA measures have much reduced the nuclear uncertainties of the ^{22}Ne and ^{23}Na AGB ejecta, which drop from factors of $\simeq 10$ to only a factor of few for the lowest metallicity models. Relying on the most recent estimations for the destruction rate of ^{23}Na, the uncertainties that still affect the ^{22}Ne and ^{23}Na AGB ejecta are mainly dominated by evolutionary aspects (efficiency of mass-loss, third dredge-up, convection). Finally, we discuss how the LUNA results impact on the hypothesis that invokes massive AGB stars as the main agents of the observed O–Na anti-correlation in Galactic globular clusters. We derive quantitative indications on the efficiencies of key physical processes (mass loss, third dredge-up, sodium destruction) in order to simultaneously reproduce both the Na-rich, O-poor extreme of the anti-correlation, and the observational constraints on the CNO abundance. Results for the corresponding chemical ejecta are made publicly available.

Accepted for publication in MNRAS
Available from http://arxiv.org/abs/1611.07742

An observational study of dust nucleation in Mira (o Ceti) II. Titanium oxides are negligible for nucleation at high temperatures

T. Kamiński[1,2], H.S.P. Müller[3], M.R. Schmidt[4], I. Cherchneff[5], K.T. Wong[6], S. Brünken[3], K.M. Menten[6], J.M. Winters[7], C.A. Gottlieb[2] and N.A. Patel[2]

[1]ESO, Chile
[2]CfA, USA
[3]Uni. Köln, Germany
[4]NCAC Toruń, Poland
[5]Uni. Basel, Switzerland
[6]MPIfR, Germany
[7]IRAM, France

Context: The formation of silicate dust in oxygen-rich envelopes of evolved stars is thought to be initiated by the formation of seed particles that can withstand the high temperatures close to the stellar photosphere and act as condensation cores farther away from the star. TiO and TiO_2 are among the candidate species considered as first condensates.
Aims: We aim to identify and characterize the circumstellar gas-phase chemistry of titanium that leads to the formation of solid titanium compounds in the envelope of o Ceti, the prototypical Mira, and seek an observational verification of whether titanium oxides play a major role in the onset of dust formation in M-type asymptotic giant branch (AGB) stars.
Methods: We present high angular resolution (145 mas) ALMA observations at submillimeter (submm) wavelengths supplemented by APEX and *Herschel* spectra of the rotational features of TiO and TiO_2. In addition, circumstellar features of TiO and Ti I are identified in optical spectra, which cover multiple pulsation cycles of o Ceti.
Results: The submm ALMA data reveal TiO and TiO_2 bearing gas within the extended atmosphere of Mira. While TiO is traceable up to a radius (FWHM/2) of 4.0 $R_{\star}$, TiO_2 extends as far as 5.5 $R_{\star}$ and, unlike TiO, appears to be anisotropically distributed. Optical spectra display variable emission of Ti I and TiO from inner parts of the extended atmosphere ($< 3\ R_{\star}$).
Conclusions: Chemical models that include shocks are in general agreement with the observations of gas-phase, titanium-bearing molecules. It is unlikely that substantial amounts of titanium is locked up in solids because the abundance of the gaseous titanium species is very high. The formation of hot titanium-rich condensates is very improbable because we find no traces of their hot precursor species in the gas phase. It therefore appears unlikely that the formation of dust in Mira, and possibly other M-type AGB stars, is initiated by titanium oxides.

Accepted for publication in A&A
Available from http://arxiv.org/abs/1610.01141

Breaking news from the HST: The central star of the Stingray Nebula is now returning towards the AGB

Nicole Reindl[1,2], *T. Rauch*[2], *M.M. Miller Bertolami*[3], *H. Todt*[4] *and K. Werner*[2]

[1]Department of Physics and Astronomy, University of Leicester, University Road, Leicester LE1 7RH, UK

[2]Institute for Astronomy and Astrophysics, Kepler Center for Astro and Particle Physics, Eberhard Karls University, Sand 1, 72076 Tübingen, Germany

[3]Instituto de Astrofísica de La Plata, UNLP–CONICET, La Plata, Buenos Aires, 1900, Argentina

[4]Institute for Physics and Astronomy, University of Potsdam, Karl-Liebknecht-Str. 24 / 25, 14476 Potsdam, Germany

SAO 244567 is a rare example of a star that allows us to witness stellar evolution in real time. Between 1971 and 1990 it changed from a B-type star into the hot central star of the Stingray Nebula. This observed rapid heating has been a mystery for decades, since it is in strong contradiction with the low mass of the star and canonical post-asymptotic giant branch (AGB) evolution. We speculated that SAO 244567 might have suffered from a late thermal pulse (LTP) and obtained new observations with HST/COS to follow the evolution of the surface properties of SAO 244567 and to verify the LTP hypothesis. Our non-LTE spectral analysis reveals that the star cooled significantly since 2002 and that its envelope is now expanding. Therefore, we conclude that SAO 244567 is currently on its way back towards the AGB, which strongly supports the LTP hypothesis. A comparison with state-of-the-art LTP evolutionary calculations shows that these models cannot fully reproduce the evolution of all surface parameters simultaneously, pointing out possible shortcomings of stellar evolution models. Thereby, SAO 244567 keeps on challenging stellar evolution theory and we highly encourage further investigations.

Published in MNRAS Letters
Available from http://arxiv.org/abs/1609.07113
and from http://mnrasl.oxfordjournals.org/content/464/1/L51

ALMA observations of the nearby AGB star L_2 Puppis. I. Mass of the central star and detection of a candidate planet

Pierre Kervella[1,2], *Ward Homan*[3], *Anita M.S. Richards*[4], *Leen Decin*[3], *Iain McDonald*[4], *Miguel Montargès*[5] *and Keiichi Ohnaka*[6]

[1]CNRA UMI FCA, U. de Chile, Chile

[2]Observatoire de Paris, LESIA, France

[3]Institute of Astronomy, K.U. Leuven, Belgium

[4]JBCA, Department Physics and Astronomy, University of Manchester, United Kingdom

[5]Institut de Radioastronomie Millimétrique, France

[6]Universidad Católica del Norte, Instituto de Astronomía, Chile

Six billion years from now, while evolving on the asymptotic giant branch (AGB), the Sun will metamorphose from a red giant into a beautiful planetary nebula. This spectacular evolution will impact the Solar System planets, but observational confirmations of the predictions of evolution models are still elusive as no planet orbiting an AGB star has yet been discovered. The nearby AGB red giant L_2 Puppis ($d = 64$ pc) is surrounded by an almost edge-on circumstellar dust disk. We report new observations with ALMA at very high angular resolution (18×15 mas^2) in band 7 ($f \sim 350$ GHz) that allow us to resolve the velocity profile of the molecular disk. We establish that the gas velocity profile is Keplerian within the central cavity of the dust disk, allowing us to derive the mass of the central star L_2 Pup A, $m_A = 0.659 \pm 0.011 \pm 0.041$ $M_\odot$ ($\pm 6.6\%$). From evolutionary models, we determine that L_2 Pup A had a near-solar main sequence mass, and is therefore a close analog of the future Sun in 5 to 6 Gyr. The continuum map reveals the presence of a secondary source (B) at a radius of 2 au contributing $f_B/f_A = 1.3 \pm 0.1\%$ of the flux of the AGB star. L_2 Pup B is also detected in CO emission lines at a radial velocity of $v_B = 12.2 \pm 1.0$ km s^{-1}. The close coincidence of the center of rotation of the gaseous disk with the position of the continuum emission from the AGB star allows us to constrain the mass of the companion to $m_B = 12 \pm 16$ M_{Jup}. L_2 Pup B is most likely a planet or low mass brown dwarf with an orbital period around 5 years. Its continuum brightness and molecular emission suggest that it may be surrounded by an extended molecular atmosphere or an accretion disk. L_2 Pup therefore emerges as a

promising vantage point on the distant future of our Solar System.

Accepted for publication in Astronomy & Astrophysics
Available from http://arxiv.org/abs/1611.06231

An investigation of the RCB star candidate GDS J0702414−023501

S. Hümmerich[1,2] and K. Bernhard[1,2]

[1]Bundesdeutsche Arbeitsgemeinschaft für Veränderliche Sterne e.V. (BAV), Germany
[2]American Association of Variable Star Observers (AAVSO), USA

2MASS J07024146−0235017 = GDS J0702414−023501 was included in the "Catalogue enriched with R CrB stars" on grounds of its near- and mid-infrared colours. The object, which corresponds to the carbon star IRAS 07001−0230 = CGCS 6197, has been found to exhibit large amplitude variability in its Bochum Galactic Disk Survey light curve. Taking into account all available data, GDS J0702414−023501 is here proposed as a new candidate Mira star.

Published in IBVS
Available from http://arxiv.org/abs/1611.08614
and from http://ibvs.konkoly.hu/cgi-bin/IBVS?6188

Detection of thermal radio emission from a single coronal giant

Eamon O'Gorman[1], Graham M. Harper[2] and Wouter Vlemmings[3]

[1]Dublin Institute for Advanced Studies, 31 Fitzwilliam Place, Dublin 2, Ireland
[2]Center for Astrophysics and Space Astronomy, University of Colorado, 389 UCB, Boulder, CO 80309, USA
[3]Department of Earth and Space Sciences, Chalmers University of Technology, Onsala Space Observatory, 439 92 Onsala, Sweden

We report the detection of thermal continuum radio emission from the K0 III coronal giant Pollux (β Gem) with the Karl G. Jansky Very Large Array (VLA). The star was detected at 21 and 9 GHz with flux density values of 150 ± 21 and 43 ± 8 μJy, respectively. We also place a $3\sigma_{\rm rms}$ upper limit of 23 μJy for the flux density at 3 GHz. We find the stellar disk-averaged brightness temperatures to be approximately 9500, 15000, and $< 71,000$ K, at 21, 9, and 3 GHz, respectively, which are consistent with the values of the quiet Sun. The emission is most likely dominated by optically thick thermal emission from an upper chromosphere at 21 and 9 GHz. We discuss other possible additional sources of emission at all frequencies and show that there may also be a small contribution from gyroresonance emission above active regions, coronal free–free emission and free–free emission from an optically thin stellar wind, particularly at the lower frequencies. We constrain the maximum mass-loss rate from Pollux to be less than 3.7×10^{-11} $M_\odot$ yr^{-1} (assuming a wind terminal velocity of 215 km s^{-1}), which is about an order of magnitude smaller than previous constraints for coronal giants and is in agreement with existing predictions for the mass-loss rate of Pollux. These are the first detections of thermal radio emission from a single (i.e., non-binary) coronal giant and demonstrate that low activity coronal giants like Pollux have atmospheres at radio frequencies akin to the quiet Sun.

Accepted for publication in Astronomy and Astrophysics
Available from http://arxiv.org/abs/1611.08412

Constraining stellar physics from red-giant stars in binaries – stellar rotation, mixing processes and stellar activity

P.G. Beck[1]*, T. Kallinger*[2]*, K. Pavlovski*[3]*, A. Palacios*[4]*, A. Tkachenko*[5]*, R.A. García*[1]*, S. Mathis*[1]*, E. Corsaro*[1]*, C. Johnston*[5]*, B. Mosser*[6]*, T. Ceillier*[1]*, J.-D. do Nascimento Jr.*[7,8] *and G. Raskin*[5]

[1]Laboratoire AIM Paris-Saclay, CEA/DRF – CNRS – Université Paris Diderot, IRFU/SAp Centre de Saclay, F-91191 Gif-sur-Yvette Cedex, France

[2]Institut für Astronomie der Universität Wien, Türkenschanzstr. 17, 1180 Wien, Austria

[3]Department of Physics, Faculty of Science, University of Zagreb, Croatia

[4]LUPM, Université Montpellier II, Place Eugéne Bataillon cc-0072, F-34095, Montpellier cedex 5, France

[5]Instituut voor Sterrenkunde, K.U. Leuven, 3001 Leuven, Belgium

[6]LESIA, CNRS, Université Pierre et Marie Curie, Université Denis Diderot, Observatoire de Paris, 92195 Meudon cedex, France

[7]Harvard–Smithsonian Center for Astrophysics, Cambridge, MA 02138, USA

[8]Departamento de Física Teórica e Experimental, Universidade Federal do Rio Grande do Norte, Brasil

The unparalleled photometric data obtained by NASA's *Kepler* Space Telescope has led to an improved understanding of stellar structure and evolution – in particular for solar-like oscillators in this context. Binary stars are fascinating objects. Because they were formed together, binary systems provide a set of two stars with very well constrained parameters. Those can be used to study properties and physical processes, such as the stellar rotation, dynamics and rotational mixing of elements and allows us to learn from the differences we find between the two components. In this work, we discussed a detailed study of the binary system KIC 9163796, discovered through *Kepler* photometry. The ground-based follow-up spectroscopy showed that this system is a double-lined spectroscopic binary, with a mass ratio close to unity. However, the fundamental parameters of the components of this system as well as their lithium abundances differ substantially. *Kepler* photometry of this system allows to perform a detailed seismic analysis as well as to derive the orbital period and the surface rotation rate of the primary component of the system. Indications of the seismic signature of the secondary are found. The differing parameters are best explained with both components located in the early and the late phase of the first dredge up at the bottom of the red-giant branch. Observed lithium abundances in both components are in good agreement with prediction of stellar models including rotational mixing. By combining observations and theory, a comprehensive picture of the system can be drawn.

Oral contribution, published in the KASC meeting "Seismology of the Sun and the Distant Stars 2016"
Available from http://arxiv.org/abs/1611.01402

Rapidly rotating red giants

Charlotte Gehan[1]*, Benoît Mosser*[1] *and Eric Michel*[1]

[1]Observatoire de Paris, LESIA, Université Pierre et Marie Curie, Université Paris Diderot, PSL, France

Stellar oscillations give seismic information on the internal properties of stars. Red giants are targets of interest since they present mixed modes, which behave as pressure modes in the convective envelope and as gravity modes in the radiative core. Mixed modes thus directly probe red giant cores, and allow in particular the study of their mean core rotation. The high-quality data obtained by CoRoT and *Kepler* satellites represent an unprecedented perspective to obtain thousands of measurements of red giant core rotation, in order to improve our understanding of stellar physics in deep stellar interiors. We developed an automated method to obtain such core rotation measurements and validated it for stars on the red giant branch. In this work, we particularly focus on the specific application of this method to red giants having a rapid core rotation. They show complex spectra where it is tricky to disentangle rotational splittings from mixed-mode period spacings. We demonstrate that the method based on the identification of mode crossings is precise and efficient. The determination of the mean core rotation directly derives from the precise measurement of the asymptotic period spacing $\Delta\Pi_1$ and of the frequency at which the crossing of the rotational components is observed.

Poster contribution, published in "Astro Fluid 2016 Conference", EAS Publications Series
Available from http://arxiv.org/abs/1611.00540

Molecular studies of planetary nebulæ

Yong Zhang[1,2]

[1]Department of Physics, The University of Hong Kong, Pokfulam Road, Hong Kong, China

[2]Laboratory for Space Research, Faculty of Science, The University of Hong Kong, Pokfulam Road, Hong Kong, China

Circumstellar envelopes (CEs) around evolved stars are an active site for the production of molecules. After evolving through the Asymptotic Giant Branch (AGB), proto-planetary nebula (PPN), to planetary nebula (PN) phases, CEs ultimately merge with the interstellar medium (ISM). The study of molecules in PNe, therefore, is essential to understanding the transition from stellar to interstellar materials. So far, over 20 molecular species have been discovered in PNe. The molecular composition of PNe is rather different from those of AGB and PPNe, suggesting that the molecules synthesized in PN progenitors have been heavily processed by strong ultraviolet radiation from the central star. Intriguingly, fullerenes and complex organic compounds having aromatic and aliphatic structures can be rapidly formed and largely survive during the PPN/PN evolution. The similar molecular compositions in PNe and diffuse clouds as well as the detection of C_{60}^{+} in the ISM reinforce the view that the mass-loss from PNe can significantly enrich the ISM with molecular species, some of which may be responsible for the diffuse interstellar bands. In this contribution, I briefly summarize some recent observations of molecules in PNe, with emphasis on their implications on circumstellar chemistry.

Oral contribution, published in IAU Symp. 323: "Planetary nebulæ: Multi-wavelength probes of stellar and galactic evolution"
Available from http://arxiv.org/abs/1611.03593

The binary central star of Hf 38

Helen Barker[1]

[1]The University of Manchester, UK

Despite years of effort, the impact of central star binarity on planetary nebula formation and shaping remains unclear. This is hampered by the fact that detecting central star binarity is inherently difficult, and requires very precise observations. The fraction of planetary nebulæ with binary central stars therefore remains elusive. This work presents initial results of central star analysis using data from the VST Hα Survey of the Southern Galactic Plane and Bulge (VPHAS+). The true central star of PN Hf 38 has been revealed, and it exhibits a 0.465 ± 0.334 i-band magnitude excess, indicative of a M0 V companion.

Poster contribution, published in IAUS 323: "Planetary Nebulæ: Multi-wavelength probes of Stellar and Galactic Evolution"
Available from http://arxiv.org/abs/1611.02559

White dwarfs in the metal-rich open cluster NGC 6253

Elizabeth Jeffery[1], *Fabiola Campos*[2], *Alejandra Romero*[3] *and S.O. Kepler*[3]

[1]Brigham Young University, USA

[2]University of Texas at Austin, USA

[3]Universidade Federal do Rio Grande do Sul, Brasil

We have obtained 53 images with the g filter and 19 images with the i filter, each with 600-second exposures of the super metal rich open cluster NGC 6253 with the Gemini-South telescope to create deep images of the cluster to observe the cluster white dwarfs for the first time. We will analyze the white dwarf luminosity function to measure the cluster's white dwarf age, search for any anomalous features (as has been seen in the similarly metal rich cluster NGC 6791), and constrain the initial-final mass relation at high metallicities. We present an update on these observations and our

program to study the formation of white dwarfs in super high metallicity environments.

Oral contribution, published in "20th European White Dwarf Workshop"
Available from http://arxiv.org/abs/1611.02687

Central stars of planetary nebulæ

David Jones[1,2]

[1]IAC, Spain
[2]Universidad de La Laguna, Spain

In this brief invited review, I will attempt to summarise some of the key areas of interest in the study of central stars of planetary nebulæ which (probably) won't be covered by other speakers' proceedings. The main focus will, inevitably, be on the subject of multiplicity, with special emphasis on recent results regarding triple central star systems as well as wide binaries which avoid a common-envelope phase. Furthermore, in light of the upcoming release of *Kepler*'s Campaign 11 data, I will discuss a few of the prospects from those data including the unique possibility to detect merger products.

Oral contribution, published in IAUS323: "Planetary nebulæ: Multiwavelength probes of stellar and galactic evolution"
Available from http://arxiv.org/abs/1611.08454

Imaging the elusive H-poor gas in planetary nebulæ with large abundance discrepancy factors

Jorge García-Rojas[1,2], *Romano L.M. Corradi*[3,1], *Henri M.J. Boffin*[4], *Hektor Monteiro*[5], *David Jones*[1,2], *Roger Wesson*[6], *Antonio Cabrera-Lavers*[3,1] *and Pablo Rodríguez-Gil*[1,2]

[1]Instituto de Astrofísica de Canarias, Tenerife, Spain
[2]Universidad de La Laguna, tenerife, Spain
[3]Gran Telescopio de Canarias, La Palma, Spain
[4]European Southern Observatory, Garching bei München, Germany
[5]Univ. Federal Itajubá, Brasil
[6]University College London, UK

The discrepancy between abundances computed using optical recombination lines (ORLs) and collisionally excited lines (CELs) is a major, unresolved problem with significant implications for the determination of chemical abundances throughout the Universe. In planetary nebulæ (PNe), the most common explanation for the discrepancy is that two different gas phases coexist: a hot component with standard metallicity, and a much colder plasma enhanced in heavy elements. This dual nature is not predicted by mass loss theories, and direct observational support for it is still weak. In this work, we present our recent findings that demonstrate that the largest abundance discrepancies are associated with close binary central stars. OSIRIS-GTC tunable filter imaging of the faint O II ORLs and MUSE-VLT deep 2D spectrophotometry confirm that O II ORL emission is more centrally concentrated than that of [O III] CELs and, therefore, that the abundance discrepancy may be closely linked to binary evolution.

Oral contribution, published in IAU Symp. 323 "Planetary nebulæ: Multiwavelength probes of stellar and galactic evolution", eds. X.-W. Liu, L. Stanghellini and A. Karakas
Available from http://arxiv.org/abs/1611.05486

Planetary nebula candidates uncovered with the HASH research platform

Vasiliki Fragkou[1,2], *Ivan Bojičić*[1,2], *David Frew*[1,2] *and Quentin Parker*[1,2]

[1]The University of Hong Kong, Department of Physics, Hong Kong SAR, China

[2]The University of Hong Kong, Laboratory for Space Research, Hong Kong SAR, China

A detailed examination of new high quality radio catalogues (e.g., Cornish) in combination with available mid-infrared (MIR) satellite imagery (e.g., Glimpse) has allowed us to find 70 new planetary nebula (PN) candidates based on existing knowledge of their typical colors and fluxes. To further examine the nature of these sources, multiple diagnostic tools have been applied to these candidates based on published data and on available imagery in the HASH (Hong Kong/ AAO/ Strasbourg Hα planetary nebula) research platform. Some candidates have previously-missed optical counterparts allowing for spectroscopic follow-up. Indeed, the single object spectroscopically observed so far has turned out to be a bona fide PN.

Poster contribution, published in IAU Symposium 323 (2017)
Available from http://arxiv.org/abs/1611.08590

Review Paper

Period changes and evolution in pulsating variable stars

Hilding R. Neilson[1], *John R. Percy*[1] *and Horace A. Smith*[2]

[1]Department of Astronomy and Astrophysics, University of Toronto, Toronto ON, M5S 3H4, Canada

[2]Department of Physics and Astronomy, Michigan State University, East Lansing, MI 48824-2320, USA

We review ways in which observations of the changing periods of pulsating variable stars can be used to detect and directly measure their evolution. We briefly describe the two main techniques of analysis – (O–C) analysis and wavelet analysis – and results for pulsating variable star types which are reasonably periodic: type I and III Cepheids, RR Lyræ stars, β Cephei stars, and Mira stars. We comment briefly on δ Scuti stars and pulsating white dwarfs. For some of these variable star types, observations agree approximately with the predictions of evolutionary models, but there still exist significant areas of disagreement that challenge future models of stellar evolution. There may be a need, for instance, to include processes such as rotation, mass loss, and magnetic fields. There may also be non-evolutionary processes which are contributing to the period changes.

Published in JAAVSO
Available from http://arxiv.org/abs/1611.03030
and from https://www.aavso.org/apps/jaavso/article/3243

Job Advert

Nanocosmos postdoctoral contract at the OAN, Spain

Type: Postdoctoral
Institution: Observatorio Astronómico Nacional (IGN)
Country: Spain
Duration: 2 years
Deadline: 16/12/2016

Attention to:
Javier Alcolea / Valentín Bujarrabal
Observatorio Astronómico Nacional

Email address for contact and inquiries:
j.alcolea@oan.es / v.bujarrabal@oan.es

CSIC, the Spanish National Research Council, will soon open applications for a post-doctoral fellowship funded by the ERC-SyG 2013 project "Gas and dust from the stars to the laboratory: exploring the Nanocosmos" NANOCOSMOS (see the web pages of the project http://www.icmm.csic.es/nanocosmos for additional information). The awarded candidate will conduct research at the Observatorio Astronómico Nacional, the Spanish National Observatory (OAN/IGN), under the collaboration agreement between CSIC and OAN/IGN. The successful candidate will join the OAN team working on evolved stars, collaborating in studies on molecular emission and dust formation (dust nucleation and grain growth) in the inner circumstellar layers of O-rich evolved stars and molecule-rich components of young planetary nebulæ, which are being carried out by the OAN team in the framework of the NANOCOSMOS project. More precisely, the team is involved in the study of the condensation of refractory species in the circumstellar envelopes of O-rich stars (depletion of refractory molecules and gas acceleration due to grain growth) and the evolution of the nebular structure, kinematics, and chemistry during the first phases of planetary nebulæ formation. The team members have preferential access to astronomical facilities such as the IRAM instruments and the OAN/IGN 40m radio-telescope; they also have a high success rate in ALMA proposals.

The selection of the candidate will be done via the CSIC job bank system; consult the web pages at https://www.bolsatrabajo.csic.es/bolsa_trabajo/ for further details on eligibility conditions and evaluation rules. We are seeking for individuals with experience in several of the following fields: evolved stars: AGB and post-AGB stars, planetary nebulæ; radioastronomy: mm- and sub-mm wave radio astronomy; spectroscopy: molecular spectroscopy; interferometry: mm- and sub-mm connected interferometry. The annual gross salary will be around €27,000, distributed in 14 monthly wage payments. Funding for travels and workshop / conference attendance is also covered by the project. Computing facilities, business equipment, and office amenities will be provided by the OAN. Individuals interested in the position, please contact the OAN team members cited above as soon as possible; in any case before the quoted deadline.

Announcements

Nature Astronomy is open for submissions

Nature Astronomy is a truly multidisciplinary journal, launching in January 2017. It will represent – and foster closer interaction between – all of the key astronomy-relevant disciplines. As a Nature Research journal, it will publish the most significant research, review and comment at the cutting edge of astronomy, astrophysics, cosmology and planetary science.

Nature Astronomy will offer a range of content types – including original research, Review Articles, Perspectives, Commentaries, News & Views and Research Highlights – to explore topical issues as well as showcasing significant advances in the field.

Publication in Nature Astronomy is free of charge, and its publication policy allows the posting of submitted manuscripts on preprint servers, and the self-archiving of the published versions of papers six months after publication.

Please visit the Nature Astronomy website for more information and to submit a manuscript:
www.nature.com/natureastronomy

See also http://go.nature.com/2eJeYck

Stellar Magnetism: Challenges, Connections, and Prospects
14^{th} Potsdam Thinkshop, June 12–16, 2017

The conference offers to diverse communities a venue to discuss the latest results, to evaluate the progress made, to understand relevant issues for both the massive and low mass star communities in a joint setting, and to examine the challenges and prospects for the next few years.

The scientific programme will highlight the most recent observational and theoretical work in the field including, but not limited to, the following topics:

- the origin of stellar magnetic fields
- magnetic field geometry and evolution in pre-main-sequence stars
- magnetic fields, rotation, and differential rotation on the main sequence
- the role of small-scale magnetic fields in stellar atmospheres
- global dynamos, activity cycles, and the rotation–activity–age relation in solar-type stars
- magnetic fields in massive stars and magnetically-confined winds
- magnetic star/planet and disk/planet interaction
- magnetism in the late stages of stellar evolution
- future perspectives in theory and observational facilities

SOC:

- Sydney Barnes (AIP Potsdam)
- Axel Brandenburg (Nordita, Stokholm University)
- Alfio Bonanno (INAF, Catánia Astrophysical Observatory)
- Manfred Küker (AIP Potsdam)
- Caroline D'Angelo (Leiden Observatory)
- Swetlana Hubrig (chair, AIP Potsdam)
- Silva Järvinen (co-chair, AIP Potsdam)
- Gautier Mathys (JAO/ESO, Chile)
- Ansgar Reiners (Universität Göttingen)
- Matthias Steffen (AIP Potsdam)
- Klaus Straßmeier (AIP Potsdam)

LOC:

- Katrin Böhrs (AIP Potsdam)
- Silva Järvinen (chair, AIP Potsdam)
- Arto Järvinen (AIP Potsdam)
- Matthias Mallonn (AIP Potsdam)

Venue: Telegrafenberg, Potsdam, Germany

Registration and abstract submission will be opened on the 5^{th} of January 2017.

See also https://thinkshop.aip.de/14/