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Editors: Jacco van Loon and Albert Zijlstra

Editorial

Dear Colleagues,

It is a pleasure to present you the 193$^{\rm rd}$ issue of the AGB Newsletter; no less than three independent works relate to AGB stars and their descendants in the Andromeda Nebula (M 31)!

It is sad to have to report the passing of Margherita Hack. Maurizio Busso kindly wrote a beautiful obituary for her.

Don't forget about the Dust conference in Taiwan later this year.

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

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

Why do technetium-poor Miras have higher dust mass-loss rates than Tc-rich Miras at the same pulsation period? (cf. Uttenthaler 2013)

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)

Margherita Hack (Florence, June 1922; Trieste, June 2013)

Obituary (by M. Busso, University of Perugia)

At the end of the last month, on June 29th, we have lost a great teacher, a prominent figure in the panorama of modern Astrophysics. Many of us have also lost a dear friend. In that day, Margherita Hack, 91, died in Trieste after a few days of hospitalization for heart problems. She left her dear Aldo, the companion, the friend and the husband who had been silently and faithfully near her for more than 70 years. She also left a very special first-actor position in the international astronomical panorama, and an even more crucial role on the Italian scientific and socio-political stage.

Born in Florence in 1922, she was one of the first outstanding Italian female figures in professional science. She succeeded (after long efforts that took her for several years around the world, from France to the United Kingdom, from Mexico to the United States) in achieving a leading position, as the first woman with a Full Professorship in Astronomy and with the Direction of the Astronomical Observatory of Trieste (which she coordinated until 1987(*)). Trieste soon became her new town, second in her heart only to the beloved Florence, where she had obtained her degree in 1945. Her thesis was a work in collaboration with the Arcetri Observatory, a study of the spectral properties of Cepheid variables. Spectroscopy itself (performed at optical and later at ultraviolet wavelengths) remained her main field of work for most of her career, with contributions through original research and top-level teaching, enriched by a famous treatise, "Stellar Spectroscopy", written in collaboration with Otto Struve, when she was at Berkley, in 1959. In spectroscopy, namely in the coordination of the data flow from the IUE (International Ultraviolet Explorer) experiment, she also showed to the whole community remarkable skills as a rigorous and efficient manager.

Retired in 1993, she nevertheless continued to write and contribute to science, developing a special gift for speaking to the wide public, making Astrophysics popular also thanks to her witty humor, her Tuscan accent and her friendly character, very far from the "*prima-donna*" behavior of other scholars. With these unmatched qualities, she succeeded in making popular also her peculiar roots and ways of life; born from an unconventional family of theosophist anti-fascists, she was for the whole of her life a strict vegetarian and a tolerant, but convinced atheist. She was also a socialist, supporting the parties of the left wing up to being elected to the Italian Parliament by them. But above all, she was a lover of

animals, especially of cats; her beloved cats that so frequently took her in trouble with the University administration and with her neighbors.

Her role was for many years crucial for awakening the interest toward science in a country still embedded in an old-fashioned, classical-like culture; a culture that she could manage well (having studied Greek and Latin) but that she was also able to overcome, to complete and expand, showing how science can be today a new way available to mankind for developing a true Humanism.

Her skill as a lively proposer of science to the public soon made her a television star. In Italy, some of her performances in popular science shows and in the connected debates have become pieces in the history of broadcasting. The examples might be many. In a famous series dedicated to mysteries and paranormal pseudo-science, she was asked by a woman-journalist how could she be so skeptical, which explanation could she provide for the many stories certifying the existence of (even the meeting with) UFOs. She answered, in the typical slang from Florence and with a candid smile: "It's simple; it's because the pricks' mom is always pregnant". (The original word was not "prick", obviously, but "bischero"; a politically-incorrect Tuscan term in the translation of which we don't need to embark). Another famous, sincere way of answering, usually with a laugh and with her most innocent expression, was: "You are asking me why! Well: I don't know!". And her recent biography actually takes the title from this sentence of hers, where all her childlike curiosity for Nature is contained. Indeed, while spending her whole life inquiring "why" things are the way they are, what she wanted most was to admire, to share, to discover, to show, to get more reasons to be marveled by the many, fantastic "hows" of Nature, much like children do, when they start exploring the world.

Now you also know the "why", dear Margherita, if any "why" exists for us to understand. In any case, we're sure that, if there is another life after this one that we know, then you'll also be a star there.

(*) A few years earlier, another woman, 13 years older than Margherita and one of the most distinguished personalities of Italian science in the XXth century, faced similar difficulties for finding her way through the research world. She was Rita Levi Montalicini, Nobel Prize for Medicine in 1986, who also died a few months ago, after turning her 103rd birthday.

Refereed Journal Papers

Dust around R Coronæ Borealis stars: II. Infrared emission features in a H-poor environment

D.A. García-Hernández[1,2], N. Kameswara Rao[3] and D.L. Lambert[4]

[1]Instituto de Astrofísica de Canarias (IAC), Spain
[2]Universidad de La Laguna (ULL), Spain
[3]Indian Institute of Astrophysics (IIA), India
[4]McDonald Observatory, UT, USA

Residual *Spitzer*/IRS spectra for a sample of 31 R Coronæ Borealis (RCB) stars are presented and discussed in terms of narrow emission features superimposed on the quasi-blackbody continuous infrared emission. A broad $\sim$ 6–10 μm dust emission complex is seen in the RCBs showing an extreme H-deficiency. A secondary and much weaker $\sim$ 11.5–15 μm broad emission feature is detected in a few RCBs with the strongest $\sim$ 6–10 μm dust complex. The *Spitzer* infrared spectra reveal for the first time the structure within the $\sim$ 6–10 μm dust complex, showing the presence of strong C–C stretching modes at $\sim$ 6.3 and 8.1 μm as well as of other dust features at $\sim$ 5.9, 6.9, and 7.3 μm, which are attributable to amorphous carbonaceous solids with little or no hydrogen. The few RCBs with only moderate H-deficiencies display the classical 'unidentified infrared bands (UIRs)' and mid-infrared features from fullerene-related molecules. In general, the characteristics of the RCB infrared emission features are not correlated with the stellar and circumstellar properties, suggesting that the RCB dust features may not be dependent on the present physical conditions around RCB stars. The only exception seems to be the central wavelength of the 6.3 μm feature, which is blue-shifted in those RCBs showing also the UIRs, i.e., the RCBs with the smallest H deficiency.

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and from http://rialto.ll.iac.es/folleto/research/preprints/?c=view&pre_id=13043

Outflows from evolved stars: the rapidly changing fingers of CRL 618

Bruce Balick[1], Martín Huarte-Espinosa[2], Adam Frank[2], Thomas Gomez[3], Javier Alcolea[4], Romano L.M. Corradi[5] and Dejan Vinković[6]

[1]Department of Astronomy, University of Washington, Seattle, WA 98195-1580, USA
[2]Department of Physics and Astronomy, University of Rochester, Rochester, NY 14627, USA
[3]Astronomy Department, University of Texas, Austin, TX 78731-2330, USA
[4]Observatorio Astronómico Nacional (IGN), E-28014 Madrid, Spain
[5]Instituto de Astrofísica de Canarias, E-38200 La Laguna, Tenerife, Spain
[6]Physics Department, University of Split, Teslina 12/III, HR-21000 Split, Croatia

Our ultimate goal is to probe the nature of the collimator of the outflows in the pre PN CRL 618. CRL 618 is uniquely suited for this purpose owing to its multiple, bright, and carefully studied finger-shaped outflows east and west of its nucleus. We compare new HST images to images in the same filters observed as much as 11 yr previously to uncover large proper motions and surface brightness changes in its multiple finger-shaped outflows. Our deep IR images reveal the structure of the surrounding medium into which the outflows propagate and interact. Tightly constrained three-dimensional ("3D") hydrodynamic models link the properties of the fingers to their possible formation histories. Finally we incorporate previously published complementary information to discern whether the fingers of CRL 618 are the results of several simultaneous steady, collimated, outflows on several flow axes or a brief ejection event that launched a set of bullets about a century ago.

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Metal-rich PNe in the outer reaches of M 31

Bruce Balick[1], *Karen B. Kwitter*[2], *R.L.M. Corradi*[3] *and R.B.C. Henry*[4]

[1]Department of Astronomy, University of Washington, Seattle, WA 98195-1580, USA

[2]Department of Astronomy, Williams College, Williamstown, MA 01267, USA

[3]Instituto de Astrofísica de Canarias, E-38200 La Laguna, Tenerife, Spain

[4]H.L. Dodge Department of Physics & Astronomy, University of Oklahoma, Norman, OK 73019, USA

Spectroscopic data of two relatively [O III]-luminous-PNe have been obtained with the 10.4-m Gran Telescopio Canarias. M 174 and M 2496 are each $\sim 1^\circ$ from the center of M 31 along opposite sides of its minor axis. The ensemble of these two distant PNe plus 16 similarly luminous outer-disk PNe published earlier (Kwitter et al. 2012 & 2013) forms a homogeneous group in luminosity, metal content, progenitor mass, age, and kinematics. The main factual findings of our work are: (1) O/H (and other low-mass α elements and their ratios to O) is uniformly solar-like in all 18 PNe $\langle 12 + \log(\mathrm{O/H})\rangle = 8.62 \pm 0.14$); (2) the general sky distribution and kinematics of the ensemble much more closely resemble the rotation pattern of the classical disk of M 31 than its halo or bulge; (3) the O/H gradient is surprisingly flat beyond $R_\mathrm{g} \sim 30$ kpc, and may be flat throughout the entire range of $\mathrm{R_g}$ covered in the full study. The PNe are too metal-rich to be bona fide members of M 31's disk or halo, and (4) the abundance patterns of the sample are distinct from those in the spiral galaxies M 33, M 81, and NGC 300. Using standard PN age diagnostic methods (which are readily challengeable) we suggest that all of the PNe formed -2 Gyr ago in a starburst of metal-rich ISM that followed an M 31–M 33 encounter about 3 Gyr ago. We review supporting evidence from stellar studies. Other more prosaic explanations, such as dwarf galaxy assimilation, are unlikely.

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Photoluminescence in amorphous $MgSiO_3$ silicate

S.P. Thompson[1], *J.E. Parker*[1], *S.J. Day*[1,2], *L.D. Connor*[1] *and A. Evans*[2]

[1]Diamond Light Source, Harwell Science and Innovation Campus, Chilton, Didcot, Oxon OX11 0QX, UK

[2]Astrophysics Group, Keele University, Keele, Staffordshire ST5 5BG, UK

Samples of amorphous $MgSiO_3$ annealed at temperature steps leading up to their crystallisation temperature show a rise in photoluminescence activity, peaking at $\sim$ 450 °C. The photoluminescence band has a main peak at 595 nm and a weaker peak at 624 nm. We present laboratory data to show that the maximum in photoluminescence activity is related to substantial structural reordering that occurs within a relatively narrow temperature range. We attribute the origin of the photoluminescence to non-bridging oxygen hole centre defects, which form around ordered nano-sized domain structures as a result of the breakup of tetrahedral connectivity in the disordered inter-domain network, aided by the loss of bonded OH. These defects are removed as crystallisation progresses, resulting in the decrease and eventual loss of photoluminescence. Thermally processed hydrogenated amorphous silicate grains could therefore represent a potential carrier of extended red emission.

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Implications of rapid core rotation in red giants for internal angular momentum transport in stars

Jamie Tayar[1] *and Marc H. Pinsonneault*[1]

[1]Ohio State University, USA

Core rotation rates have been measured for red giant stars using asteroseismology. This data, along with helioseismic measurements and open cluster spin down studies, provide powerful clues about the nature and timescale for internal

angular momentum transport in stars. We focus on two cases: the metal poor red giant KIC 7341231 ("Otto") and intermediate mass core helium burning stars. For both we examine limiting case studies for angular momentum coupling between cores and envelopes under the assumption of rigid rotation on the main sequence. We discuss the expected pattern of core rotation as a function of mass and radius. In the case of Otto, strong post-main-sequence coupling is ruled out and the measured core rotation rate is in the range of 23 to 33 times the surface value expected from standard spin down models. The minimum coupling time scale (0.17–0.45 Gyr) is significantly longer than that inferred for young open cluster stars. This implies ineffective internal angular momentum transport in early first ascent giants. By contrast, the core rotation rates of evolved secondary clump stars are found to be consistent with strong coupling given their rapid main sequence rotation. An extrapolation to the white dwarf regime predicts rotation periods between 330 and 0.0052 days depending on mass and decoupling time. We identify two key ingredients that explain these features: the presence of a convective core and inefficient angular momentum transport in the presence of larger mean molecular weight gradients. Observational tests that can disentangle these effects are discussed.

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The effects of rotation on the s-process nucleosynthesis in Asymptotic Giant Branch stars

Luciano Piersanti[1]*, Sergio Cristallo*[1] *and Oscar Straniero*[1]

[1]Osservatorio Astronomico di Teramo (INAF), via Maggini sn, Teramo, 64100, Italy

In this paper we analyze the effects induced by rotation on low mass Asymptotic Giant Branch stars. We compute two sets of models, $M = 2.0$ $M_\odot$ at [Fe/H] $= 0$ and $M = 1.5$ $M_\odot$ at [Fe/H] $= -1.7$, respectively, by adopting Main Sequence rotation velocities in the range 0–120 km s^{-1}. At high metallicity, we find that the Goldreich–Schubert–Fricke instability, active at the interface between the convective envelope and the rapid rotating core, contaminates the ^{13}C-pocket (the major neutron source) with ^{14}N (the major neutron poison), thus reducing the neutron flux available for the synthesis of heavy elements. As a consequence, the yields of heavy-s elements (Ba, La, Nd, Sm) and, to a less extent, those of light-s elements (Sr, Y, Zr) decrease with increasing rotation velocities up to 60 km s^{-1}. However, for larger initial rotation velocities, the production of light-s and, to a less extent, that of heavy-s begins again to increase, due to mixing induced by meridional circulations. At low metallicity, the effects of meridional circulations are important even at rather low rotation velocity. The combined effect of Goldreich–Schubert–Fricke instability and meridional circulations determines an increase of light-s and, to a less extent, heavy-s elements, while lead is strongly reduced. For both metallicities, the rotation-induced instabilities active during the interpulse phase reduce the neutrons-to-seeds ratio, so that the spectroscopic indices [hs/ls] and [Pb/hs] decrease by increasing the initial rotation velocity. Our analysis suggests that rotation could explain the spread in the s-process indices, as observed in s-process enriched stars at different metallicities.

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A snowflake's chance in heaven

Mark Walker[1]

[1]Manly Astrophysics, Australia

We consider the survival of solid H_2 in the diffuse interstellar medium, with application to grains which are small enough to qualify as dust. Consideration of only the thermal aspects of this problem leads to the familiar conclusion that such grains sublimate rapidly. Here we show that charging plays a critical role in determining the sublimation rate, because an electric field helps to bind molecules to the grain surface. A key aspect of the charging process is that the conduction band of solid hydrogen lies above the vacuum free-electron energy level, so low-energy electrons cannot penetrate the solid. But they are attracted by the dielectric and by positive ions in the matrix, so they become trapped

in vacuum states just above the surface. This charge-separated configuration suppresses recombination and permits overall neutrality, while supporting large electric fields at the surface. Charging ceases when the potential energy just outside the electron layer coincides with the conduction band minimum. By that stage the heat of sublimation has increased tenfold, effecting a huge reduction in the sublimation rate. Consequently hydrogen grains may be able to survive indefinitely in the diffuse ISM. There are good prospects for identifying H_2 grains, if they exist, as fully-localised surface electrons should exhibit discrete energy levels, with a corresponding spectral line signature.

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The spatiokinematical structure of H_2O and OH masers in the "water fountain" source IRAS 18460−0151

Hiroshi Imai[1,2], *Shuji Deguchi*[3], *Jun-ichi Nakashima*[4], *Sun Kwok*[4] *and Philip J. Diamond*[5]

[1]Kagoshima University, Japan
[2]ICRAR/University of Western Australia, Australia
[3]Nobeyama Radio Observatory, NAOJ, Japan
[4]The University of Hong Kong, China
[5]SKA Organisation, UK

Using the Very Long Baseline Array and the European VLBI Network, we have observed 22.2-GHz H_2O and 1612-MHz OH masers in the "water fountain" source IRAS 18460−0151. The H_2O maser spectrum has a very wide line-of-sight velocity range (≈ 310 km s^{-1}) and consists of three groups of emission features at the blue-shifted (-68 km s$^{-1}\lesssim v_{\rm LSR}\lesssim -17$ km s^{-1}) and red-shifted ($v_{\rm LSR}\simeq 240$ km s^{-1}) edges as well as around the systemic velocity (112 km s$^{-1}\lesssim v_{\rm LSR}\lesssim$133 km s^{-1}). The first two H_2O spectral components exhibit a highly-collimated high-velocity bipolar jet on the sky, with an angular separation of ≈ 120 milliarcseconds (mas) (240 au in linear length) and a three-dimensional flow velocity of ≈ 160 km s^{-1}. The flow dynamical age is estimated to be only ≈ 6 yr (at the time of the observation epochs of 2006–2007). Interestingly, the systemic velocity component clearly exhibits a spherically-expanding outflow with a radius of ≈ 36 au and a flow velocity of ≈ 9 km s^{-1}. On the other hand, the OH maser spectrum shows double peaks with a velocity separation of ≈ 25 km s^{-1} ($v_{\rm LSR}=111$–116 and 138–141 km s^{-1}), as typically seen in circumstellar envelopes of OH/IR stars. The angular offset between the velocity-integrated brightness peaks of the two high-velocity H_2O components is ≈ 25 mas (50 au). The offset direction and the alignment of the red-shifted maser spots are roughly perpendicular to the axis of the H_2O maser flow. High-accuracy astrometry for the H_2O and OH masers demonstrates that the collimated fast jet and the slowly expanding outflow originate from a single or multiple sources which are located within 15 mas (30 au). On the other hand, the estimated systemic velocity of the collimated jet ($v_{\rm sys}\approx 87$–113 km s^{-1}) has a large uncertainty. This makes it difficult to provide strong constraints on models of the central stellar system of IRAS 18460−0151.

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Extended rotating disks around post-AGB stars

V. Bujarrabal[1], *J. Alcolea*[2], *H. Van Winckel*[3], *M. Santander-García*[2] *and A. Castro-Carrizo*[4]

[1]OAN, Spain; v.bujarrabal@oan.es
[2]OAN, Madrid, Spain
[3]KU Leuven, Belgium
[4]IRAM Grenoble, France

There is a group of binary post-AGB stars that show a conspicuous NIR excess, usually assumed to arise from hot dust in very compact possibly rotating disks. These stars are surrounded by significantly fainter nebulae than the "standard", well studied protoplanetary and planetary nebulæ (PPNe, PNe), and, at least some of them, have

significantly lower luminosities.
We aim to identify and study extended rotating disks around these stars, shedding light on the role of disks in the formation and shaping of planetary nebulæ.
We present high-sensitivity mm-wave observations of CO lines in 24 objects of this type. The resulting CO lines are compared with profiles expected to arise from rotating disks, both from theoretical and observational grounds. We derive simple formulae that allow determining the mass of the CO-emitting gas and estimating its extent; the reliability and uncertainty of the methods are widely discussed.
CO emission is detected in most observed sources and the line profiles show that the emissions very probably come from disks in rotation. We derive typical values of the disk mass between 10^{-3} and 10^{-2} $M_{\odot}$, about two orders of magnitude smaller than the (total) masses of "standard" PPNe. The high-detection rate (upper limits being in fact not very significant) clearly confirm that the NIR excess of these stars arises from compact disks in rotation, very probably the inner parts of those found here. Low-velocity outflows are also found in about eight objects, with moderate expansion velocities of ~ 10 km s^{-1}, to be compared with the velocities of about 100 km s^{-1} often found in "standard" PPNe. Except for two sources with complex profiles, the outflowing gas in our objects represents a minor nebular component. Our simple estimates of the disk typical sizes yields values $\sim 0\farcs5$–$1''$, i.e. between 5×10^{15} and 3×10^{16} cm. Estimates of the linear momenta carried by the outflows, which can only be performed in a few well studied objects, also yield moderate values, compared with the linear momenta that can be released by the stellar radiation pressure (contrary, again, to the case of the very massive and fast bipolar outflows in "standard" PPNe, that are strongly overluminous). The mass and dynamics of nebulae around various classes of post-AGB stars differ very significantly, and we can expect the formation of PNe with very different properties.

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Is there a metallicity ceiling to form carbon stars? – A novel technique reveals a scarcity of C-stars in the inner M 31 disk

M.L. Boyer[1], *L. Girardi*[2], *P. Marigo*[3], *B.F. Williams*[4], *B. Aringer*[5], *W. Nowotny*[5], *P. Rosenfield*[4], *C.E. Dorman*[6], *P. Guhathakurta*[6], *J.J. Dalcanton* [4], *J.L. Melbourne*[7], *K.A.G. Olsen*[8] *and D.R. Weisz*[4]

[1]NASA Goddard Space Flight Center, Code 665, USA
[2]Osservatorio Astronomico di Padova, Italy
[3]Department of Physics and Astronomy G. Galilei, University of Padova, Italy
[4]Department of Astronomy, University of Washington, USA
[5]University of Vienna, Department of Astrophysics, Austria
[6]University of California Observatories/LickO bservatory, University of California, USA
[7]Caltech Optical Observatories, Division of Physics, Mathematics and Astronomy, USA
[8]National Optical Astronomy Observatory, USA

We use medium-band near-infrared (NIR) *Hubble* Space Telescope WFC3 photometry with model NIR spectra of Asymptotic Giant Branch (AGB) stars to develop a new tool for efficiently distinguishing carbon-rich (C-type) AGB stars from oxygen-rich (M-type) AGB stars in galaxies at the edge of and outside the Local Group. We present the results of a test of this method on a region of the inner disk of M 31, where we find a surprising lack of C stars, contrary to the findings of previous C star searches in other regions of M 31. We find only 1 candidate C star (plus up to 6 additional, less certain C stars candidates), resulting in an extremely low ratio of C to M stars ($C/M = (3.3^{+20}_{-0.1}) \times 10^{-4}$) that is 1–2 orders of magnitude lower than other C/M estimates in M 31. The low C/M ratio is likely due to the high metallicity in this region which impedes stars from achieving $C/O > 1$ in their atmospheres. These observations provide stringent constraints to evolutionary models of metal-rich AGB stars and suggest that there is a metallicity threshold above which M stars are unable to make the transition to C stars, dramatically affecting AGB mass loss and dust production and, consequently, the observed global properties of metal-rich galaxies.

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Spectroscopic observations of planetary nebulæ in the Northern Spur of M 31

Xuan Fang[1], *Yong Zhang*[2], *Ruben García-Benito*[3], *Xiao-Wei Liu*[1,4] *and Hai-Bo Yuan*[4,5]

[1]Department of Astronomy, School of Physics, Peking University, Beijing 100871, China

[2]Department of Physics, University of Hong Kong, Hong Kong, China

[3]Instituto de Astrofísica de Andalucia (CSIC), Glorieta de la Astronomía s/n, E-18008 Granada, Spain

[4]Kavli Institute for Astronomy and Astrophysics, Peking University, Beijing 100871, China

[5]LAMOST Fellow

We present spectroscopy of three planetary nebulæ (PNe) in the Northern Spur of the Andromeda Galaxy (M 31) obtained with the Double Spectrograph on the 5.1-m *Hale* Telescope at the Palomar Observatory. The samples are selected from the observations of Merrett et al. Our purpose is to investigate formation of the substructures of M 31 using PNe as a tracer of chemical abundances. The [O III] 4363 line is detected in the spectra of two objects, enabling temperature determinations. Ionic abundances are derived from the observed collisionally excited lines, and elemental abundances of nitrogen, oxygen, and neon as well as sulphur and argon are estimated. Correlations between oxygen and the α-element abundance ratios are studied, using our sample and the M 31 disk and bulge PNe from the literature. In one of the three PNe, we observed relatively higher oxygen abundance compared to the disk sample in M 31 at similar galactocentric distances. The results of at least one of the three Northern Spur PNe might be in line with the proposed possible origin of the Northern Spur substructure of M 31, i.e. the Northern Spur is connected to the Southern Stream and both substructures comprise the tidal debris of the satellite galaxies of M 31.

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Resonances in the photoionization cross sections of atomic nitrogen shape the far-ultraviolet spectrum of the Bright Star in 47 Tucanæ

William V. Dixon[1] *and Pierre Chayer*[1]

[1]STScI, USA

The far-ultraviolet (FUV) spectrum of the Bright Star (B8 III) in 47 Tuc (NGC 104) shows a remarkable pattern: it is well fit by LTE models at wavelengths longer than Lymanβ, but at shorter wavelengths it is fainter than the models by a factor of two. A spectrum of this star obtained with the Far Ultraviolet Spectroscopic Explorer (FUSE) shows broad absorption troughs with sharp edges at 995 and 1010 Å and a deep absorption feature at 1072 Å, none of which are predicted by the models. We find that these features are caused by resonances in the photoionization cross sections of the first and second excited states of atomic nitrogen ($2s^2\ 2p^3\ ^2D^0$ and $^2P^0$). Using cross sections from the Opacity Project, we can reproduce these features, but only if we use the cross sections at their full resolution, rather than the resonance-averaged cross sections usually employed to model stellar atmospheres. These resonances are strongest in stellar atmospheres with enhanced nitrogen and depleted carbon abundances, a pattern typical of post-AGB stars.

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Twenty-five sub-arcsecond binaries discovered by lunar occultations

A. Richichi[1], *O. Fors*[2,3], *F. Cusano*[4] *and M. Mörchen*[5,6]

[1]National Astronomical Research Institute of Thailand, 191 Siriphanich Bldg., Huay Kaew Rd., Suthep, Muang, Chiang Mai 50200, Thailand

[2]Departament Astronomia i Meteorologia and Institut de Ciències del Cosmos (ICC), Universitat de Barcelona (UB/IEEC), Martí i Franqués 1, 08028 Barcelona, Spain

[3]Observatori Fabra, Camí de l'Observatori s/n, 08035, Barcelona, Spain

[4]INAF–Osservatorio Astronomico di Bologna, Via Ranzani 1, 40127 Bologna, Italy

[5]European Southern Observatory, Casilla 19001, Santiago 19, Chile

[6]Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA

We report on 25 sub-arcsecond binaries, detected for the first time by means of lunar occultations in the near-infrared as part of a long-term program using the ISAAC instrument at the ESO Very Large Telescope. The primaries have magnitudes in the range $K = 3.8$ to 10.4, and the companions in the range $K = 6.4$ to 12.1. The magnitude differences have a median value of 2.8, with the largest being 5.4. The projected separations are in the range 6 to 748 milliarcseconds and with a median of 18 milliarcseconds, or about 3 times less than the diffraction limit of the telescope. Among our binary detections are a pre-main sequence star and an enigmatic Mira-like variable previously suspected to have a companion. Additionally, we quote an accurate first-time near-IR detection of a previously known wider binary.

We discuss our findings on an individual basis as far as made possible by the available literature, and we examine them from a statistical point of view. We derive a typical frequency of binarity among field stars of $\approx 10\%$, in the resolution and sensitivity range afforded by the technique ($\approx 0\farcs003$ to $\approx 0\farcs5$, and $K \approx 12$ mag, respectively). This is in line with previous results by the same technique but we point out interesting differences that we can trace up to sensitivity, time sampling, and average distance of the targets. Finally, we discuss the prospects for further follow-up studies.

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Steady twin-jets orientation: implications for their formation mechanism

Noam Soker[1] *and Liron Mcley*[1]

[1]Technion, Israel

We compare the structures of the jets of the pre-planetary nebulae (PN) CRL 618 and the young stellar object (YSO) NGC 1333 IRAS4A2 and propose that in both cases the jets are launched near periastron passages of a highly eccentric binary system. The pre-PN CRL 618 has two 'twin-jets' on each side, where by 'twin-jets' we refer to a structure where one side is composed of two very close and narrow jets that were launched at the same time. We analyze the position–velocity diagram of NGC 1333 IRAS4A2, and find that it also has the twin-jets structure. In both systems the orientation of the two twin-jets does not change with time. By comparing these two seemingly different objects, we speculate that the constant relative direction of the two twin-jets is fixed by the direction of a highly eccentric orbit of a binary star. For example, a double-arm spiral structure in the accretion disk induced by the companion might lead to the launching of the twin-jets. We predict the presence of a low-mass stelar companion in CRL 618 that accretes mass and launches the jets, and a substellar (a planet of a brown dwarf) companion to the YSO NGC 1333 IRAS4A2 that perturbed the accretion disk. In both cases the orbit has a high eccentricity.

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Observations and three-dimensional ionization structure of the planetary nebula SuWt 2

Ashkbiz Danehkar[1], *Quentin A. Parker*[1,2] *and Barbara Ercolano*[3,4]

[1]Research Centre in Astronomy, Astrophysics & Astrophotonics, Macquarie University, Sydney, NSW 2109, Australia

[2]Australian Astronomical Observatory, P.O. Box 296, Epping, NSW 1710, Australia

[3]Universitäts-Sternwarte München, Ludwig-Maxmilians Universität München, Scheinerstr. 1, D-81679 München, Germany

[4]Excellence Cluster Universe, Boltzmannstr. 2, D-85748 Garching bei München, Germany

The planetary nebula SuWt 2 (PN G 311.0+02.4), is an unusual object with a prominent, inclined central emission ellipse and faint bipolar extensions. It has two A-type stars in a proven binary system at the centre. However, the radiation from these two central stars is too soft to ionize the surrounding material leading to a so far fruitless search for the responsible ionizing source. Such a source is clearly required and has already been inferred to exist via an observed temporal variation of the centre-of-mass velocity of the A-type stars. Moreover, the ejected nebula is nitrogen-rich which raises question about the mass-loss process from a likely intermediate-mass progenitor. We use optical integral-field spectroscopy to study the emission lines of the inner nebula ring. This has enabled us to perform an empirical analysis of the optical collisionally excited lines, together with a fully three-dimensional photoionization modelling. Our empirical results are used to constrain the photoionization models, which determine the evolutionary stage of the responsible ionizing source and its likely progenitor. The time-scale for the evolutionary track of a hydrogen-rich model atmosphere is inconsistent with the dynamical age obtained for the ring. This suggests that the central star has undergone a very late thermal pulse. We conclude that the ionizing star could be hydrogen-deficient and compatible with what is known as a PG 1159-type star. The evolutionary tracks for the very late thermal pulse models imply a central star mass of ~ 0.64 $M_\odot$, which originated from a ~ 3 $M_\odot$ progenitor. The evolutionary time-scales suggest that the central star left the asymptotic giant branch about 25,000 years ago, which is consistent with the nebula's age.

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CEN 34 – high-mass YSO in M 17 or background post-AGB star?

Zhiwei Chen[1,2,3], *Dieter Nürnberger*[2], *Rolf Chini*[2,4], *Yao Liu*[1], *Min Fang*[1] *and Zhibo Jiang*[1]

[1]Purple Mountain Observatory, Chinese Academy of Sciences, Nanjing 210008, China

[2]Institute for Astronomy, Ruhr-University Bochum, Bochum 44801, Germany

[3]University of Chinese Academy of Sciences, Beijing 100039, China

[4]Instituto de Astronomía, Universidad Católica del Norte, Antofagasta Casilla 1280, Chile

We investigate the proposed high-mass young stellar object (YSO) candidate CEN 34, thought to be associated with the star forming region M 17. Its optical to near-infrared (550–2500 nm) spectrum reveals several photospheric absorption features, such as Hα, Ca triplet and CO bandheads but lacks any emission lines. The spectral features in the range 8375–8770 Å are used to constrain an effective temperature of 5250 ± 250 K (early-/mid-G) and a surface gravity of 2.0 ± 0.3 (supergiant). The spectral energy distribution of CEN 34 resembles the SED of a high-mass YSO or an evolved star. Moreover, the observed temperature and surface gravity are identical for high-mass YSOs and evolved stars. The radial velocity relative to LSR (v_{LSR}) of CEN 34 as obtained from various photospheric lines is of the order of -60 km s^{-1} and thus distinct from the $+25$ km s^{-1} found for several OB stars in the cluster and for the associated molecular cloud. The SED modeling yields $\sim 10^{-4}$ $M_\odot$ of circumstellar material which contributes only a tiny fraction to the total visual extinction (11 mag). In the case of a YSO, a dynamical ejection process is proposed to explain the v_{LSR} difference between CEN 34 and M 17. Additionally, to match the temperature and luminosity, we speculate that CEN 34 had accumulated the bulk of its mass with accretion rate $> 4 \times 10^{-3}$ $M_\odot$ yr^{-1} in a very short time span ($\sim 10^3$ yr), and currently undergoes a phase of gravitational contraction without any further mass gain. However, all the aforementioned characteristics of CEN 34 are compatible with an evolved star of 5–7 $M_\odot$ and an age of 50–100 Myr, most likely a background post-AGB star with a distance between 2.0 kpc and 4.5 kpc. We consider the latter

classification as the more likely interpretation. Further discrimination between the two possible scenarios should come from the more strict confinement of CEN 34's distance.

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Alignment of the angular momentum vectors of planetary nebulæ in the Galactic Bulge

B. Rees[1] *and A.A. Zijlstra*[1]

[1]Jodrell Bank Centre for Astrophysics, The Alan Turing Building, School of Physics and Astronomy, The University of Manchester, Oxford Road, Manchester M13 9PL, UK

We use high-resolution Hα images of 130 planetary nebulæ (PNe) to investigate whether there is a preferred orientation for PNe within the Galactic Bulge. The orientations of the full sample have an uniform distribution. However, at a significance level of 0.01, there is evidence for a non-uniform distribution for those planetary nebulæ with evident bipolar morphology. If we assume that the bipolar PNe have an unimodal distribution of the polar axis in Galactic coordinates, the mean Galactic position angle is consistent with 90°, i.e. along the Galactic Plane, and the significance level is better than 0.001 (the equivalent of a 3.7σ significance level for a Gaussian distribution).
The shapes of PNe are related to angular momentum of the original star or stellar system, where the long axis of the nebula measures the angular momentum vector. In old, low-mass stars, the angular momentum is largely in binary orbital motion. Consequently, the alignment of bipolar nebulæ that we have found indicates that the orbital planes of the binary systems are oriented perpendicular to the Galactic Plane. We propose that strong magnetic fields aligned along the Galactic Plane acted during the original star formation process to slow the contraction of the star forming cloud in the direction perpendicular to the Plane. This would have produced a propensity for wider binaries with higher angular momentum with orbital axes parallel to the Galactic Plane. Our findings provide the first indication of a strong, organized magnetic field along the Galactic Plane that impacted on the angular momentum vectors of the resulting stellar population.

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Radiative transfer modelling of dust in IRAS 18333−2357: The only planetary nebula in the metal-poor globular cluster M 22

C. Muthumariappan[1]*, M. Parthasarathy*[2] *and Y. Ita*[3]

[1]Indian Institute of Astrophysics, Koramangala, Bangalore 560034, India

[2]Inter-University Centre for Astronomy & Astrophysics (IUCAA), Post Bag 4, Ganeshkhind, Pune 411007, India

[3]Astronomical Institute, Tohoku University, 6-3 Aramaki, Aoba-ku Sendai, 980-8578, Japan

We report results from our 1-D radiative transfer modelling of dust in the hydrogen-deficient planetary nebula IRAS 18333−2357 located in the globular cluster M 22. A spectral energy distribution was constructed from archival UV, optical and IR data including Akari photometry at its 18-, 65-, 90-, 140- and 160-μm bands. An archival *Spitzer* spectrum shows several aromatic infrared bands indicating a carbon-rich dust shell. The spectral energy distribution is well fit by a model which considers a modified Mathis–Rumpl–Nordsieck grain size distribution and a radial density function which includes compression of the nebula by its interaction with the Galactic Halo gas. The model indicates a significant amount of cold dust, down to a temperature of 50 K, is present at the outer edge of the nebula. At the inner edge the dust temperature is 97 K. The dust shell has a size of $26'' \pm 6.3''$. We find a large amount of excess emission, over the emission from thermal equilibrium dust, in the mid-IR region. This excess emission may have originated from the thermally fluctuating dust grains with size ~ 12 Å in the UV field of the hot central star. These

grains, however, come from the same population and conditions as the thermal equilibrium grains. The dust mass of this grain population is $(1.2 \pm 0.73) \times 10^{-3}$ $M_\odot$ and for the thermal equilibrium grains it is $(1.4 \pm 0.60) \times 10^{-4}$ $M_\odot$, leading to a total dust mass of $(1.3 \pm 0.91) \times 10^{-3}$ $M_\odot$. The derived dust-to-gas mass ratio is 0.3 ± 0.21.
For a derived bolometric luminosity of 1700 ± 1230 $L_\odot$ and an assumed central star mass of 0.55 ± 0.02 $M_\odot$, the surface gravity is derived to be $\log g = 4.6 \pm 0.24$. We propose that the progenitor of IRAS 18333−2357 had possibly evolved from an early stellar merger case and the hydrogen-deficient nebula results from a late thermal pulse. The hydrogen-rich nebula, which was ejected by the progenitor during its normal AGB evolution, might have been stripped off by its strong interaction with the Galactic Halo gas.

Accepted for publication in MNRAS

ALMA observations of the Red Rectangle, a preliminary analysis

V. Bujarrabal[1]*, A. Castro-Carrizo*[2]*, J. Alcolea*[3]*, H. Van Winckel*[4]*, C. Sánchez Contreras*[5]*, M. Santander-García*[3,5]*, R. Neri*[2] *and R. Lucas*[6]

[1]OAN, Spain, v.bujarrabal@oan.es
[2]IRAM, France
[3]OAN–Madrid, Spain
[4]KU Leuven, Belgium
[5]CAB, Spain
[6]UJF–Grenoble, France

We aim to study equatorial disks in rotation and axial outflows in post-AGB objects, so as to disclose the formation and shaping mechanisms in planetary nebulæ. So far, both disks and outflows have not been observed simultaneously. We obtained high-quality ALMA observations of ^{12}CO and ^{13}CO $J = 3$–2 and ^{12}CO $J = 6$–5 line emission in the Red Rectangle, the only post-AGB/protoplanetary object for which a disk in rotation has been mapped.
These observations provide an unprecedented description of the complex structure of this source. Together with an equatorial disk in rotation, we find a low-velocity outflow that more or less occupies the region situated between the disk and the optical X-shaped nebula. From our observations and preliminary modeling of the data, we confirm the previously known properties of the disk and obtain a first description of the structure, dynamics, and physical conditions of the outflow.

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Available from arXiv:1307.5959

Modelling the nucleosynthetic properties of carbon-enhanced metal-poor RR Lyræ stars

Richard J. Stancliffe[1,2]*, Catherine R. Kennedy*[2]*, Herbert H.B. Lau*[1] *and Timothy C. Beers*[3,4]

[1]Argelander-Institut für Astronomie, Germany
[2]RSAA, Australia
[3]NOAO, USA
[4]JINA, USA

Certain carbon-enhanced metal-poor stars likely obtained their composition via pollution from some of the earliest generations of asymptotic giant branch stars and as such provide important clues to early Universe nucleosynthesis. Recently, Kinman et al. discovered that the highly carbon- and barium-enriched metal-poor star SDSS J1707+58 is in fact an RR Lyræ pulsator. This gives us an object in a definite evolutionary state where the effects of dilution of material during the Main Sequence are minimised owing to the object having passed through first dredge-up. We perform detailed stellar modelling of putative progenitor systems in which we accreted material from asymptotic giant

branch stars in the mass range 1–2 $M_\odot$. We investigate how the surface abundances are affected by the inclusion of mechanisms like thermohaline mixing and gravitational settling. While we are able to find a reasonable fit to the carbon and sodium abundances of SDSS J1707+58, suggesting accretion of around 0.1 $M_\odot$ from a 2-$M_\odot$ companion, the strontium and barium abundances remain problematic and this object may have experienced something other than a standard *s* process. We have more success in fitting the abundances of the mildly carbon-enriched, metal-poor RR Lyræ pulsator TY Gru (CS 22881−071), which we suggest received 0.1 $M_\odot$ of material from a companion of around 1 $M_\odot$.

Accepted for publication in MNRAS
Available from arXiv:1307.4762

Conference Papers

Unidentified species in envelopes around carbon stars

Biwei Jiang[1], *Aigen Li*[2], *Ke Zhang*[3], *Jiaming Liu*[1], *Jian Gao*[1] *and Ajay Mishra*[2]

[1]Department of Astronomy, Beijing Normal University, China
[2]Department of Physics and Astronomy, University of Missouri, USA
[3]Californina Institute of Technology, USA

The infrared (IR) spectra of many evolved carbon-rich stars exhibit two prominent dust emission features peaking around 21 μm and 30 μm, with the former exclusively seen in proto-planetary nebulæ (PPNe), while the latter seen in a much wider range of objects, including AGB stars, PPNe and planetary nebulæ (PNe). The 30 μm feature is seen in all the 21-μm sources, but no correlation is found between these two features. Over a dozen carrier candidates have been proposed for the 21-μm feature, but none of them has been widely accepted and the nature of the 21-μm feature remains a mystery. The carrier of the 30-μm feature also remains unidentied. MgS dust, once widely accepted as a valid carrier, was ruled out because of the sulfur budget problem. In this work we examine nano-sized FeO dust as a carrier for the 21-μm feature. We calculate the IR emission spectrum of FeO nanodust which undergoes single-photon heating in PPNe. It is found that the 21-μm feature emitted by FeO nanodust is too broad to explain the observed feature. For the 30-μm feature, we argue that graphite could be a viable carrier. Graphite, provided its d.c. conductivity $\sigma_{\rm dc}$ exceeding 100 Ω^{-1} cm^{-1}, exhibits a pronounced band at 30 μm.

Poster contribution, published in IAUS 297, "Diffuse Interstellar Bands"
Available from arXiv:1307.4014

Diffuse interstellar bands in (proto-) fullerene-rich environments

D.A. García-Hernández[1,2]

[1]Instituto de Astrofísica de Canarias (IAC), Spain
[2]Universidad de La Laguna (ULL), Spain

The recent infrared detection of fullerenes (C_{60} and C_{70}) in Planetary Nebulæ (PNe) and R Coronæ Borealis (RCB) stars offers a beautiful opportunity for studying the diffuse interstellar bands (DIBs) in sources where fullerenes are abundant. Here we present for the first time a detailed inspection of the optical spectra of the hot RCB star DY Cen and two fullerene PNe (Tc 1 and M 1-20), which permits us to directly explore the fullerenes–DIB connection. The DIB spectrum of DY Cen (García-Hernández et al. 2012a) is remarkably different from that in fullerene PNe (García-Hernández & Díaz-Luis 2013). In particular, Tc 1 displays unusually strong 4428 Å and 6309 Å DIBs, which are normal (or not seen) in DY Cen. On the other hand, DY Cen displays an unusually strong 6284 Å DIB that is found to be normal in fullerene PNe. We also report the detection of new broad and unidentified features centered at 4000

Å and 6525 Å in DY Cen and Tc 1, respectively. We suggest that the new 4000 Å band seen in DY Cen may be related to the circumstellar proto-fullerenes seen at infrared wavelengths (García-Hernández et al. 2012a). However, the intense 4428 Å DIB (probably also the 6309 Å DIB and the new 6525 Å band) may be related to the presence of larger fullerenes (e.g., C_{80}, C_{240}, C_{320}, and C_{540}) and buckyonions (multishell fullerenes such as $C_{60}@C_{240}$ and $C_{60}@C_{240}@C_{540}$) in the circumstellar envelope of Tc 1 (García-Hernández & Díaz-Luis 2013).

Oral contribution, published in IAUS 297, "The Diffuse Interstellar Bands", eds. J. Cami & N. Cox
Available from arXiv:1307.3905

Spectroscopy of fullerenes, fulleranes and PAHs in the UV, visible and near infrared spectral range

F. Cataldo[1,2], D.A. García-Hernández[3,4], A. Manchado[3,4,5] and S. Iglesias-Groth[3,4]

[1]Istituto Nazionale di Astrofisica – Osservatorio Astrofisica di Catania, Italy
[2]Actinium Chemical Research, Italy
[3]Instituto de Astrofísica de Canarias (IAC), Spain
[4]Universidad de La Laguna (ULL), Spain
[5]CSIC, Spain

The spectra of fullerenes C_{60} and C_{70}, higher fullerenes C_{76}, C_{78} and C_{84} and hydrogenated fullerenes (fulleranes) were studied in laboratory in the UV and in the visible spectral range and could be used for searching and recognizing these molecules in space. Furthermore, the radical cation spectra of all the mentioned fullerene series and also of a series of large and very large polycyclic aromatic hydrocarbons (PAHs) were generated in laboratory and studied in the near infrared spectral range.

Poster contribution, published in IAUS 297, "The Diffuse Interstellar Bands", eds. J. Cami & N. Cox
Available from arXiv:1307.3936

Announcement

The Life Cycle of Dust in the Universe: Observations, Theory, and Laboratory Experiments

Second Announcement
November 18–22, 2013, Taipei, Taiwan
http://events.asiaa.sinica.edu.tw/meeting/20131118/

OBJECTIVES:
This meeting aims to address the life cycle of dust in the Universe, which covers the formation, evolution and destruction of dust in a range of environments, ranging from the smallest to the largest scales. Bringing together observational and theoretical astrophysicists as well as meteoriticists and experimentalists will allow for a cross-disciplinary dialogue.

The meeting follows a successful tradition of astrophysical dust meetings, starting in Albany in 1972, with the latest edition "Cosmic Dust: Near and Far" organized by Th. Henning taking place in Heidelberg in 2008.

Since that meeting, the field of dust astrophysics has made major leaps forward with the hoist of data arriving from such missions as the infrared space telescopes *Spitzer*, *Herschel*, and Stardust, the latter returning dust samples from comet Wild-2 currently being studied in the lab. The largest telescope on Earth, ALMA, has recently come online, allowing for investigations into the origin of dust in the Universe. Thus, this is an excellent time to review the status

of the field of dust astrophysics in this meeting.

The meeting aims to create an environment in which all aspects of the life cycle of dust will be discussed, from an astrophysical, chemical and mineralogical perspective, and the effect on a range of environments. Observational insights, theoretical models and experimental approaches all contribute to our view of the life cycle of dust, and the meeting will address new developments and future projects in all these areas.

CONFIRMED INVITED SPEAKERS:

Jean-Philippe Bernard (IRAP)

Jeroen Bouwman (MPIA)

Fred Ciesla (Chicago)

Isabelle Cherchneff (Basel)

Karine Demyk (IRAP)

Loretta Dunne (Canterbury, NZ)

Hideaki Fujiwara (NAOJ)

Christa Gall (NASA GSFC)

Hiroyuki Hirashita (ASIAA)

Edward Jenkins (Princeton)

Anthony Jones (IAS)

Hidehiro Kaneda (Nagoya)

Sun Kwok (Hong Kong)

Scott Messenger (NASA JSC)

Harald Mutschke (Jena)

Nathan Smith (Arizona)

Angela Speck (Missouri)

Sundar Srinivasan (ASIAA)

Shogo Tachibana (Tokyo)

Svitlana Zhukovska (MPIA)

The conference summary will be given by Thomas Henning (MPIA).

SCIENTIFIC ORGANIZING COMMITTEE:

Anja Andersen (DARK)

Maarten Baes (Ghent)

Eli Dwek (NASA GSFC)

Haley Gomez (Cardiff)

Karl Gordon (STScI)

Lei Hao (Shanghai)

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Vito Mennella (Capodimonte)

Michiel Min (Amsterdam)

Takashi Onaka (Tokyo)

Itsuki Sakon (Tokyo)

Raffaella Schneider (Roma)

Darach Watson (DARK)

VENUE:
International Conference Hall, Humanities and Social Sciences Building, 3F, Academia Sinica 128 Academia Road, Section 2, Nankang, Taipei, Taiwan.

The meeting is held on the Academia Sinica (AS) main campus, which is different from the National Taiwan University (NTU) campus where Institute of Astronomy and Astrophysics, Academia Sinica (ASIAA) is located.

PROCEEDINGS:
We plan to publish conference proceedings.

EXCURSIONS:
Through a local tour agency, we will offer two excursions, which can be booked separately from the conference registration.

On Wednesday afternoon (20 November), we will visit the famous eroded coast of Yeliu with its beautiful rock formations, followed by a visit to the night market of Keelung.

On the weekend after the conference (23 & 24 November), a two-day trip to Taroko Gorge will be offered. This scenic canyon on Taiwan's east coast is definitely worth a visit!

The registration for these excursions will open around 1 August, and close by the end of September. More information will appear on the conference website in due course.

IMPORTANT DATES:

24 August 2013: Deadline to submit abstracts for contributed talks

24 August 2013: Deadline for regular registration

25 October 2013: Deadline to submit poster abstracts

25 October 2013: Deadline for late registration

18–22 November 2013: Conference dates

23–24 November 2013: Optional 2-day excursion to Taroko Gorge

25–26 November 2013: NanoSIMS inauguration and isotope workshop

WEBSITE & REGISTRATION:
Additional information on this meeting can be found at http://events.asiaa.sinica.edu.tw/meeting/20131118/

The on-line registration for this meeting is now open, and the regular registration fee is 335 USD (payment to be completed by Aug 24, 2013). Late registration is possible at a higher rate of 395 USD.

To connect with other participants prior to the conference, join our Facebook group:
https://www.facebook.com/groups/lcod2013/

ISOTOPE WORKSHOP & NANOSIMS INAUGURATION:
After the conference on "The Life Cycle of Dust in the Universe: Observations, Theory and Laboratory Experiments", there will be a 2-day workshop at Academia Sinica on 25 and 26 November 2013 in honour of Typhoon Lee's 65^{th} birthday, celebrating his contributions to the field of meteoritics and dust astrophysics. This will also be the inauguration meeting for Academia Sinica's NanoSIMS facility.

More information on this meeting will follow.

We hope to see you in Taipei in November.

Kind regards,
the SOC and LOC

Local Organizing Committee:

Tzuching Chang

Cindy Chiu

Hiroyuki Hirashita

Ciska Kemper

Lihwai Lin

Suh-Lian Lin

Ming-Chang Liu

Sheng-Yuan Liu

Ji Yeon Seok

Sundar Srinivasan

Wei-Hao Wang

Ronny Zhao-Geisler

Contact email: lcod2013@asiaa.sinica.edu.tw

See also http://events.asiaa.sinica.edu.tw/meeting/20131118/