THE AGB NEWSLETTER

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Editors: Jacco van Loon, Ambra Nanni and Albert Zijlstra

Figure 1: The planetary nebula VBRC 2 in the constellation of Vela, with its extended halo, imaged by Don Goldman and suggested by Sakib Rasool – see http://astrodonimaging.com/gallery/vbrc2-with-extended-halo/.

Editorial

Dear Colleagues,

It is a pleasure to present you the 248th issue of the AGB Newsletter. It reminds you of the excellent read that is the review by Höfner & Olofsson about mass loss, among many other interesting new results.

An observational and a theoretical postdoc position are sought to work in Leuven with Leen Decin. IAU Commission members are sought, too. And those of you interested in laboratory astrophysics might like to go to the AAS meeting; those of you working on the boundary with exoplanets might like to go to London.

The latest suggestions in our quest for the most iconic picture to be placed on the front cover of the 250th issue are those of R Scu – http://www.eso.org/public/images/eso1239a/, and R Scl – https://www.eso.org/public/news/eso1239/ (the latter suggested by Stefan Uttenthaler). Watch this space: in the next issue we will open a vote! Until then you may send us further suggestions to add to the list.

If those images entice you to take up interferometry, the Fizeau programme is (still) there to help you get started!

Last month's Food for Thought was clarified by a "yes"! The term "hyper-AGB" was introduced in 2015, in the wonderful review by Doherty, Gil-Pons, Siess and Lattanzio (MNRAS 446, 2599).

The next issue is planned to be distributed around the 1st of April.

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

Food for Thought

This month's thought-provoking statement is:

Are the RGB and RSG as asymptotic as the AGB?

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

J-band red giant branch tip magnitudes for the distance indicator

Hyun-chul Lee[1], *Cedar García*[1] *and Ivana Peña*[1]

[1]The University of Texas Rio Grande Valley, USA

The tip of the red giant branch is one of the widely used distance measurement methods for the relatively nearby galaxies where the bright individual stars are resolved. Most of the earlier works have used the photometry in the I-band such as HST ACS/WFC F814W or F850LP for the RGB tip method. Here we look into the RGB tip magnitudes in J-band such as HST WFC3/IR F110W and JWST NIRCam/WF F115W for a wide range of age and metallicity. We find that the J-band (HST WFC3/IR F110W and JWST NIRCam/WF F115W) RGB tip magnitudes do not significantly change compared to that of the I-band (HST ACS/WFC F814W, F850LP) for a wide range of metallicity at given age. Moreover, HST WFC3/IR F110W RGB tip magnitudes stay constant within 0.005 magnitudes for stellar populations with old ages (age > 5 Gyr) at given metallicity.

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Available from https://arxiv.org/abs/1711.09468
and from http://iopscience.iop.org/article/10.3847/2515-5172/aa9e07/meta

Chemical evolution with rotating massive star yields I. The solar neighborhood and the *s*-process elements

N. Prantzos[1], *C. Abia*[2], *M. Limongi*[3], *A. Chieffi* [4] *and S. Cristallo*[5]

[1]Institut d'Astrophysique de Paris, UMR7095 CNRS, Univ. P. & M. Curie, 98bis Bd. Arago, 75104 Paris, France

[2]Departmento de Física Teórica y del Cosmos, Universidad de Granada, E-18071 Granada, Spain

[3]Istituto Nazionale di Astrofisica – Osservatorio Astronomico di Roma, Via Frascati 33, I-00040, Monteporzio Catone, Italy

[4]Istituto di Astrofisica e Planetologia Spaziali, INAF, via Fosso del cavaliere 100, 00133 Roma, Italy

[5]Istituto Nazionale di Astrofisica – Osservatorio Astronomico d'Abruzzo, Via Maggini snc, I-64100, Teramo, Italy

We present a comprehensive study of the abundance evolution of the elements from H to U in the Milky Way halo and local disk. We use a consistent chemical evolution model, metallicity dependent isotopic yields from low and intermediate mass stars and yields from massive stars which include, for the first time, the combined effect of metallicity, mass loss and rotation for a large grid of stellar masses and for all stages of stellar evolution. The yields of massive stars are weighted by a metallicity dependent function of the rotational velocities, constrained by observations as to obtain a primary-like ^{14}N behavior at low metallicity and to avoid overproduction of *s*-elements at intermediate metallicities. We show that the solar system isotopic composition can be reproduced to better than a factor of two for isotopes up to the Fe-peak, and at the 10% level for most pure *s*-isotopes, both light ones (resulting from the weak *s*-process in rotating massive stars) and the heavy ones (resulting from the main *s*-process in low and intermediate mass stars). We conclude that the light element primary process (LEPP), invoked to explain the apparent abundance deficiency of the *s*-elements with $A < 100$, is not necessary. We also reproduce the evolution of the heavy to light *s*-elements abundance ratio ($[hs/ls]$) – recently observed in unevolved thin disk stars – as a result of the contribution of rotating massive stars at sub-solar metallicities. We find that those stars produce primary F and dominate its solar abundance and we confirm their role in the observed primary behavior of N. In contrast, we show that their action is insufficient to explain the small observed values of ^{12}C/^{13}C in halo red giants, which is rather due to internal processes in those stars.

Accepted for publication in MNRAS

ALMA spectral line and imaging survey of a low and a high mass-loss rate AGB star between 335 and 362 GHz

L. Decin[1], *A.M.S. Richards*[2], *T. Danilovich*[1], *W. Homan*[1] *and J.A. Nuth*[3]

[1]Instituut voor Sterrenkunde, Katholieke Universiteit Leuven, Celestijnenlaan 200D, 3001 Leuven, Belgium

[2]JBCA, Department Physics and Astronomy, University of Manchester, Manchester M13 9PL, UK

[3]NASA/GSFC, Mail Code: 690, Greenbelt, MD 20771, USA

Context: Low and intermediate mass stars are known to power strong stellar winds when evolving through the asymptotic giant branch (AGB) phase. Initial mass, luminosity, temperature, and composition determine the pulsation characteristics of the star and the dust species formed in the pulsating photospheric layers. Radiation pressure on these grains triggers the onset of a stellar wind. However, as of today, we still cannot predict the wind mass-loss rates and wind velocities from first principles neither do we know which species are the first to condense in the upper atmospheric regions.
Aims: We aim to characterise the dominant physical, dynamical, and chemical processes in the inner wind region of two archetypical oxygen-rich (C/O < 1) AGB stars, that is, the low mass-loss rate AGB star R Dor ($\dot{M} \sim 1 \times 10^{-7}$ $M_\odot$ yr^{-1}) and the high mass-loss rate AGB star IK Tau ($\dot{M} \sim 5 \times 10^{-6}$ $M_\odot$ yr^{-1}). The purpose of this study is to observe the key molecular species contributing to the formation of dust grains and to cross-link the observed line brightnesses of several species to the global and local properties of the star and its wind.
Methods: A spectral line and imaging survey of IK Tau and R Dor was made with ALMA between 335 and 362 GHz (band 7) at a spatial resolution of ~ 150 mas, which corresponds to the locus of the main dust formation region of both targets.
Results: Some two hundred spectral features from 15 molecules (and their isotopologues) were observed, including rotational lines in both the ground and vibrationally excited states (up to $v = 5$ for SiO). Detected species include the gaseous precursors of dust grains such as SiO, AlO, AlOH, TiO, and TiO_2. We present a spectral atlas for both stars and the parameters of all detected spectral features. A clear dichotomy for the sulphur chemistry is seen: while CS, SiS, SO, and SO_2 are abundantly present in IK Tau, only SO and SO_2 are detected in R Dor. Also other species such as NaCl, NS, AlO, and AlOH display a completely different behaviour. From some selected species, the minor isotopologues can be used to assess the isotopic ratios. The channel maps of many species prove that both large and small-scale inhomogeneities persist in the inner wind of both stars in the form of blobs, arcs, and/or a disk. The high sensitivity of ALMA allows us to spot the impact of these correlated density structures in the spectral line profiles. The spectral lines often display a half width at zero intensity much larger than expected from the terminal velocity, v_∞, previously derived for both objects (36 km s^{-1} versus $v_\infty \sim 17.7$ km s^{-1} for IK Tau and 23 km s^{-1} versus $v_\infty \sim 5.5$ km s^{-1} for R Dor). Both a more complex 3D morphology and a more forceful wind acceleration of the (underlying) isotropic wind can explain this trend. The formation of fractal grains in the region beyond ~ 400 mas can potentially account for the latter scenario. From the continuum map, we deduce a dust mass of $\sim 3.7 \times 10^{-7}$ $M_\odot$ and $\sim 2 \times 10^{-8}$ $M_\odot$ for IK Tau and R Dor, respectively.
Conclusions: The observations presented here provide important constraints on the properties of these two oxygen-dominated AGB stellar winds. In particular, the ALMA data prove that both the dynamical and chemical properties are vastly different for this high mass-loss rate (IK Tau) and low mass-loss rate (R Dor) star.

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Constraints on metal oxide and metal hydroxide abundances in the winds of AGB stars – Potential detection of FeO in R Dor

L. Decin[1,2], *T. Danilovich*[1], *D. Gobrecht*[1], *J.M.C. Plane*[2], *A.M.S. Richards*[3], *C.A. Gottlieb*[4] *and K.L.K. Lee*[4]

[1]Instituut voor Sterrenkunde, Katholieke Universiteit Leuven, Celestijnenlaan 200D, 3001 Leuven, Belgium

[2]University of Leeds, School of Chemistry, Leeds LS2 9JT, United Kingdom

[3]JBCA, Department Physics and Astronomy, University of Manchester, Manchester M13 9PL, UK

[4]Harvard–Smithsonian Center for Astrophysics, Cambridge, MA 02138, and School of Engineering & Applied Sciences, Harvard University, Cambridge, MA 02138, USA

Using ALMA, we observed the stellar wind of two oxygen-rich Asymptotic Giant Branch (AGB) stars, IK Tau and

R Dor, between 335 and 362 GHz. One aim was to detect metal oxides and metal hydroxides (AlO, AlOH, FeO, MgO, MgOH), some of which are thought to be direct precursors of dust nucleation and growth. We report on the potential first detection of FeO ($v = 0$, $\Omega = 4$, $J = 11$–10) in R Dor (mass-loss rate $\dot{M} \sim 1 \times 10^{-7}$ $M_\odot$ yr^{-1}). The presence of FeO in IK Tau ($\dot{M} \sim 5 \times 10^{-6}$ $M_\odot$ yr^{-1}) cannot be confirmed due to a blend with ^{29}SiS, a molecule that is absent in R Dor. The detection of AlO in R Dor and of AlOH in IK Tau was reported earlier by Decin et al. (2017). All other metal oxides and hydroxides, as well as MgS, remain undetected. We derive a column density N(FeO) of $(1.1 \pm 0.9) \times 10^{15}$ cm^{-2} in R Dor, or a fractional abundance [FeO/H] $\sim 1.5 \times 10^{-8}$ accounting for non-LTE effects. The derived fractional abundance [FeO/H] is a factor ~ 20 larger than conventional gas-phase chemical kinetic predictions. This discrepancy may be partly accounted for by the role of vibrationally excited OH in oxidizing Fe, or may be evidence for other currently unrecognised chemical pathways producing FeO. Assuming a constant fractional abundance w.r.t. H_2, the upper limits for the other metals are [MgO/H_2] $< 5.5 \times 10^{-10}$ (R Dor) and $< 7 \times 10^{-11}$ (IK Tau), [$MgOH/H_2$] $< 9 \times 10^{-9}$ (R Dor) and $< 1 \times 10^{-9}$ (IK Tau), [CaO/H_2] $< 2.5 \times 10^{-9}$ (R Dor) and $< 1 \times 10^{-10}$ (IK Tau), [$CaOH/H_2$] $< 6.5 \times 10^{-9}$ (R Dor) and $< 9 \times 10^{-10}$ (IK Tau), and [MgS/H_2] $< 4.5 \times 10^{-10}$ (R Dor) and $< 6 \times 10^{-11}$ (IK Tau). The retrieved upper limit abundances for these latter molecules are in accord with the chemical model predictions.

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Efficient common-envelope ejection through dust-driven winds

Hila Glanz[1] *and Hagai B. Perets*[1]

[1]Technion – Israel Institute of Technology, Israel

Common-envelope evolution (CEE) is the short-lived phase in the life of an interacting binary-system during which two stars orbit inside a single shared envelope. Such evolution is thought to lead to the inspiral of the binary, the ejection of the extended envelope and the formation of a remnant short-period binary. However, detailed hydrodynamical models of CEE encounter major difficulties. They show that following the inspiral most of the envelope is not ejected; though it expands to larger separations, it remains bound to the binary. Here we propose that dust-driven winds can be produced following the CEE. These can evaporate the envelope following similar processes operating in the ejection of the envelopes of AGB stars. Pulsations in an AGB-star drives the expansion of its envelope, allowing the material to cool down to low temperatures thus enabling dust condensation. Radiation pressure on the dust accelerates it, and through its coupling to the gas it drives winds which eventually completely erode the envelope. We show that the inspiral phase in CE-binaries can effectively replace the role of stellar pulsation and drive the CE expansion to scales comparable with those of AGB stars, and give rise to efficient mass-loss through dust-driven winds.

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An LTE effective temperature scale for red supergiants in the Magellanic Clouds

Hugo M. Tabernero[1], *Ricardo Dorda*[1], *Ignacio Negueruela*[1] *and Carlos González-Fernández*[2]

[1]Departamento de Física, Ingeniería de Sistemas y Teoría de la Señal, Universidad de Alicante, Spain
[2]Institute of Astronomy, University of Cambridge, UK

We present a self-consistent study of cool supergiants (CSGs) belonging to the Magellanic Clouds. We calculated stellar atmospheric parameters using LTE KURUCZ and MARCS atmospheric models for more than 400 individual targets by fitting a careful selection of weak metallic lines. We explore the existence of a T_{eff} scale and its implications in two different metallicity environments (each Magellanic Cloud). Critical and in-depth tests have been performed

to assess the reliability of our stellar parameters (i.e. internal error budget, NLTE systematics). In addition, several Monte Carlo tests have been carried out to infer the significance of the T_{eff} scale found. Our findings point towards a unique T_{eff} scale that seems to be independent of the environment.

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ExoCross: a general program for generating spectra from molecular line lists

Sergei N. Yurchenko[1], *Ahmed F. Al-Refaie*[1] *and Jonathan Tennyson*[1]

[1]Department of Physics and Astronomy, University College London, London WC1E 6BT, United Kingdom

ExoCross is a Fortran code for generating spectra (emission, absorption) and thermodynamic properties (partition function, specific heat etc.) from molecular line lists. Input is taken in several formats, including ExoMol and HITRAN formats. ExoCross is efficiently parallelized showing also a high degree of vectorization. It can work with several line profiles such as Doppler, Lorentzian and Voigt and support several broadening schemes. Voigt profiles are handled by several methods allowing fast and accurate simulations. Two of these methods are new. ExoCross is also capable of working with the recently proposed method of super-lines. It supports calculations of lifetimes, cooling functions, specific heats and other properties. ExoCross can be used to convert between different formats, such as HITRAN, ExoMol and Phoenix. It is capable of simulating non-LTE spectra using a simple two-temperature approach. Different electronic, vibronic or vibrational bands can be simulated separately using an efficient filtering scheme based on the quantum numbers.

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Available from https://arxiv.org/abs/1801.09803

Effective temperatures of red giants in the APOKASC catalogue and the mixing length calibration in stellar models

Maurizio Salaris[1], *Santi Cassisi*[2], *Ricardo P. Schiavon*[1] *and Adriano Pietrinferni*[2]

[1]ARI – Liverpool John Moores University, UK
[2]INAF – Osservatorio Astronomico d'Abruzzo, Italy

Red giants in the updated APOGEE–*Kepler* catalogue, with estimates of mass, chemical composition, surface gravity and effective temperature, have recently challenged stellar models computed under the standard assumption of solar calibrated mixing length. In this work, we critically reanalyse this sample of red giants, adopting our own stellar model calculations. Contrary to previous results, we find that the disagreement between the effective temperature scale of red giants and models with solar calibrated mixing length disappears when considering our models and the APOGEE–*Kepler* stars with scaled solar metal distribution. However, a discrepancy shows up when α-enhanced stars are included in the sample. We have found that assuming mass, chemical composition and effective temperature scale of the APOGEE–*Kepler* catalogue, stellar models generally underpredict the change of temperature of red giants caused by α-element enhancements at fixed [Fe/H]. A second important conclusion is that the choice of the outer boundary conditions employed in model calculations is critical. Effective temperature differences (metallicity dependent) between models with solar calibrated mixing length and observations appear for some choices of the boundary conditions, but this is not a general result.

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The Hα and Hβ Raman-scattering line profiles of the symbiotic star AG Peg

Seong-Jae Lee[1] *and Siek Hyung*[1]

[1]School of Science Education, Chungbuk National University, South Korea

The Hα and Hβ line profiles of the symbiotic star AG Peg observed on 1998 September (phase $\phi = 10.24$), display the top narrow double Gaussian and bottom broad (FWHM of 200–400 kms^{-1}) components. The photo-ionization model indicated that the ionized zone, responsible for the hydrogen Balmer and Lyman lines, is radiation-bounded, with a hydrogen gas number density of $n_{\mathrm{H}} \sim 10^{9.85}$ cm^{-3} and a gas temperature of $T_{\mathrm{e}} = 12\,000$–$15\,000$ K. We carried out Monte Carlo simulations to fit the Raman scattering broad wings, assuming that the hydrogen Lyβ and Lyγ lines emitted within the radiation-bounded H II zone around a white dwarf have the same double Gaußian line profile shape as the hydrogen Balmer lines. The simulation shows that the scattering H I zones are attached to (or located just outside of) the inner H II shells. The best fit to the observed broad HI line profiles indicates that the column density of the scattering neutral zone is $N_{\mathrm{H}} \simeq 3$–5×10^{19} cm^{-2}. We examined whether the geometrical structure responsible for the observed Hα and Hβ line profiles is a bipolar conical shell structure, consisting of the radiation-bounded ionized zone and the outer material bounded neutral zone. The expanding bipolar structure might be two opposite regions of the common envelope or the outer shell of the Roche lobe around the hot white dwarf, formed through the mass inflows from the giant star and pushed out by the fast winds from the hot white dwarf.

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Aluminium abundances in five discrete stellar populations of the globular cluster NGC 2808

Eugenio Carretta[1], *Angela Bragaglia*[1], *Sara Lucatello*[2], *Raffaele G. Gratton*[2], *Valentina D'Orazi*[2] *and Antonio Sollima*[1]

[1]INAF – Osservatorio di Astrofisica e Scienza dello Spazio di Bologna, Italy
[2]INAF – Osservatorio Astronomico di Padova, Italy

We observed a sample of 90 red giant branch (RGB) stars in NGC 2808 using FLAMES/GIRAFFE and the high resolution grating with the set up HR21. These stars have previous accurate atmospheric parameters and abundances of light elements. We derived aluminium abundances for them from the strong doublet Al I 8772–8773Å as in previous works of our group. In addition, we were able to estimate the relative CN abundances for 89 of the stars from the strength of a large number of CN features. When adding self consistent abundances from previous UVES spectra analysed by our team, we gathered [Al/Fe] ratios for a total of 108 RGB stars in NGC 2808. The full dataset of proton-capture elements is used to explore in details the five spectroscopically detected discrete components in this globular cluster. We found that different classes of polluters are required to reproduce the (anti)-correlations among all proton-capture elements in the populations P2, I1, and I2 with intermediate composition. This is in agreement with the detection of lithium in lower RGB second generation stars, requiring at least two kind of polluters. To have chemically homogeneous populations the best subdivision of our sample is into six components, as derived from statistical cluster analysis. By comparing different diagrams [element/Fe] vs. [element/Fe] we show for the first time that a simple dilution model is not able to reproduce all the sub-populations in this cluster. Polluters of different masses are required. NGC 2808 is confirmed to be a tough challenge to any scenario for globular cluster formation.

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On the evolutionary status of high-latitude variable V534 Lyr

V.G. Klochkova[1], *E.G. Sendzikas* [1] *and E.L. Chentsov*[1]

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

Based on the high resolution spectral monitoring performed at the 6-m BTA telescope, we study the optical spectrum of the high-latitude variable V534 Lyr. Heliocentric radial velocities Vr corresponding to the positions of all metal absorption components, as well as the Na I D and Hα lines were measured during all the observational dates. The analysis of the velocity field examining the lines of various nature revealed a low-amplitude variability of v_{rmr} based on the lines with a high excitation potential, which are formed in deep layers of the stellar atmosphere, and allowed to estimate the systemic velocity of $v_{\rm sys} \approx -125$ km s^{-1} (v(lsr) ≈ -105 km s^{-1}). The distance estimate of $d \approx 6$ kpc for the star leads us to its absolute magnitude of $M_V \approx -5.3$, what corresponds to the MK spectral classification. The previously undetected for this star spectral phenomenon was revealed: at certain times a splitting of the profiles of low-excited absorptions is observed, reaching $\Delta v_{\rm r} = 20 \div 50$ km s^{-1}. A combination of the parameters: reduced metallicity [Met/H]$_\odot = -0.28$, increased nitrogen abundance [N/Fe] = +1.10, large spatial velocity, high luminosity, a strong variability of the emission–absorption profiles of H I lines, splitting of metal absorptions at different observation moments and the variability of the velocity field in the atmosphere allow us to classify V534 Lyr as a pulsating star in the instability band near the HB and belonging to the thick disk of our Galaxy.

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The convective photosphere of the red supergiant CE Tau. I. VLTI/PIONIER H-band interferometric imaging

M. Montargès[1,2], *R. Norris*[3], *A. Chiavassa*[4], *B. Tessore*[5], *A. Lèbre*[5] *and F. Baron*[3]

[1]Institute of Astronomy, K.U. Leuven, Celestijnenlaan 200D B2401, 3001 Leuven, Belgium
[2]Institut de Radioastronomie Millimétrique, 300 rue de la Piscine, 38406, Saint Martin d'Hères, France
[3]Center for High Angular Resolution Astronomy, Georgia State University, USA
[4]Université Côte d'Azur, Observatoire de la Côte d'Azur, CNRS, Lagrange, CS 34229, Nice, France
[5]Université de Montpellier, CNRS, LUPM, Place E. Bataillon, 34090, Montpellier, France

Context: Red supergiant stars are one of the latest stages in the evolution of massive stars. Their photospheric convection may play an important role in the launching mechanism of their mass loss; however, its characteristics and dynamics are still poorly constrained.
Aims: By observing red supergiant stars with near infrared interferometry at different epochs, we expect to reveal the evolution of bright convective features on their stellar surface.
Methods: We observed the M2 Iab–Ib red supergiant star CE Tau with the VLTI/PIONIER instrument in the H band at two different epochs separated by one month.
Results: We derive the angular diameter of the star and basic stellar parameters, and reconstruct two reliable images of its H-band photosphere. The contrast of the convective pattern of the reconstructed images is $5 \pm 1\%$ and $6 \pm 1\%$ for our two epochs of observation.
Conclusions: The stellar photosphere shows few changes between the two epochs. The contrast of the convective pattern is below the average contrast variations obtained on 30 randomly chosen snapshots of the best matching 3D radiative hydrodynamics simulation: $23 \pm 1\%$ for the original simulation images and $16 \pm 1\%$ for the maps degraded to the reconstruction resolution. We offer two hypotheses to explain this observation. CE Tau may be experiencing a quiet convective activity episode or it could be a consequence of its warmer effective temperature (hence its smaller radius) compared to the simulation.

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New variable stars from the Photographic Archive: Semi-automated discoveries, attempts of automatic classification, and the new field 104 Her

S.V. Antipin[1], *I. Becker*[2], *A.A. Belinski*[1], *D.M. Kolesnikova* [3], *K. Pichara*[4,2], *N.N. Samus*[3,1], *K.V. Sokolovsky*[5,1,6], *A.V. Zharova*[1] *and A.M. Zubareva*[3,1]

[1]P.K. Sternberg Astronomical Institute, M.V. Lomonosov Moscow University, 13, University Ave., Moscow 119234, Russia

[2]Pontificia Universidad Católica de Chile, Santiago, Chile

[3]Institute of Astronomy, Russian Academy of Sciences, Moscow, 119017, Russia

[4]Institute for Applied Computational Science, Harvard University, Cambridge, MA, USA

[5]IAASARS, National Observatory of Athens, 15236 Penteli, Greece

[6]Astro Space Center of Lebedev Physical Institute, Profsoyuznaya Str. 84/32, 117997 Moscow, Russia

Using 172 plates taken with the 40-cm astrograph of the Sternberg Astronomical Institute (Lomonosov Moscow University) in 1976–1994 and digitized with the resolution of 2400 dpi, we discovered and studied 275 new variable stars. We present the list of our new variables with all necessary information concerning their brightness variations. As in our earlier studies, the new discoveries show a rather large number of high-amplitude δ Scuti variables, predicting that many stars of this type remain not detected in the whole sky. We also performed automated classification of the newly discovered variable stars based on the Random Forest algorithm. The results of the automated classification were compared to traditional classification and showed that automated classification was possible even with noisy photographic data. However, further improvement of automated techniques is needed, which is especially important having in mind the very large numbers of new discoveries expected from all-sky surveys.

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Deep learning classification in asteroseismology using an improved neural network: results on 15000 *Kepler* red giants and applications to K2 and TESS data

Marc Hon[1], *Dennis Stello*[1,2,3] *and Jie Yu*[2]

[1]School of Physics, The University of New South Wales, Sydney NSW 2052, Australia

[2]Sydney Institute for Astronomy (SIfA), School of Physics, University of Sydney, NSW 2006, Australia

[3]Stellar Astrophysics Centre, Department of Physics and Astronomy, Århus University, Ny Munkegade 120, DK-8000 Århus C, Denmark

Deep learning in the form of 1D convolutional neural networks have previously been shown to be capable of efficiently classifying the evolutionary state of oscillating red giants into red giant branch stars and helium-core burning stars by recognizing visual features in their asteroseismic frequency spectra. We elaborate further on the deep learning method by developing an improved convolutional neural network classifier. To make our method useful for current and future space missions such as K2, TESS and PLATO, we train classifiers that are able to classify the evolutionary states of lower frequency resolution spectra expected from these missions. Additionally, we provide new classifications for 8633 *Kepler* red giants, out of which 426 have previously not been classified using asteroseismology. This brings the total to 14983 *Kepler* red giants classified with our new neural network. We also verify that our classifiers are remarkably robust to suboptimal data, including low signal-to-noise and incorrect training truth labels.

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Full-dimensional quantum dynamics of SiO in Collision with H_2

Benhui Yang[1] *et al.*

[1]University of Georgia, USA

We report the first full-dimensional potential energy surface (PES) and quantum mechanical close-coupling calculations for scattering of SiO due to H_2. The full-dimensional interaction potential surface was computed using the explicitly correlated coupled-cluster (CCSD(T)-F12b) method and fitted using an invariant polynomial approach. Pure rotational quenching cross sections from initial states $v_1 = 0$, $j_1 = 1$–5 of SiO in collision with H_2 are calculated for collision energies between 1.0 and 5000 cm^{-1}. State-to-state rotational rate coefficients are calculated at temperatures between 5 and 1000 K. The rotational rate coefficients of SiO with para-H_2 are compared with previous approximate results which were obtained using SiO–He PESs or scaled from SiO–He rate coefficients. Rovibrational state-to-state and total quenching cross sections and rate coefficients for initially excited SiO ($v_1 = 1$, $j_1 = 0$ and 1) in collisions with para-H_2 ($v_2 = 0$, $j_2 = 0$) and ortho-H_2 ($v_2 = 0$, $j_2 = 1$) were also obtained. The application of the current collisional rate coefficients to astrophysics is briefly discussed.

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Wolf 1130: a nearby triple system containing a cool, ultramassive white dwarf

Gregory Mace[1], *Andrew Mann*[1], *Brian Skiff*[2], *Christopher Sneden*[1], *J. Davy Kirkpatrick*[3], *Adam Schneider*[4], *Benjamin Kidder*[1], *Natalie Gosnell*[5], *Hwihyun Kim*[6], *Brian Mulligan*[1], *Lisa Prato*[2] *and Daniel Jaffe*[1]

[1]McDonald Observatory and Department of Astronomy, University of Texas at Austin, 2515 Speedway, Stop C1400, Austin,TX 78712-1205, USA

[2]Lowell Observatory, 1400 West Mars Hill Road, Flagstaff, AZ 86001, USA

[3]IPAC, Mail Code 100-22, Caltech, 1200 E. California Boulevard, Pasadena, CA 91125, USA

[4]School of Earth and Space Exploration, Arizona State University, Tempe, AZ 85282, USA

[5]Department of Physics, Colorado College, 14 E. Cache La Poudre Street, Colorado Springs, CO 80903, USA

[6]Gemini Observatory, Casilla 603, La Serena, Chile

Following the discovery of the T8 subdwarf WISE J200520.38+542433.9 (Wolf 1130C), with common proper motion to a binary (Wolf 1130AB) consisting of an M subdwarf and a white dwarf, we set out to learn more about the old binary in the system. We find that the A and B components of Wolf 1130 are tidally locked, which is revealed by the coherence of more than a year of V band photometry phase folded to the derived orbital period of 0.4967 days. Forty new high-resolution, near-infrared spectra obtained with the Immersion Grating Infrared Spectrometer (IGRINS) provide radial velocities and a projected rotational velocity ($v \sin i$) of 14.7 ± 0.7 km s^{-1} for the M subdwarf. In tandem with a Gaia parallax-derived radius and verified tidal-locking, we calculate an inclination of $i = 29 \pm 2$ degrees. From the single-lined orbital solution and the inclination we derive an absolute mass for the unseen primary ($1.24^{+0.19}_{-0.15}$ $M_\odot$). Its non-detection between 0.2 and 2.5 μm implies that it is an old (> 3.7 Gyr) and cool ($T_{\rm eff} < 7000$ K) ONe white dwarf. This is the first ultramassive white dwarf within 25pc. The evolution of Wolf 1130AB into a cataclysmic variable is inevitable, making it a potential Type Ia supernova progenitor. The formation of a triple system with a primary mass > 100 times the tertiary mass and the survival of the system through the common-envelope phase, where $\sim 80\%$ of the system mass was lost, is remarkable. Our analysis of Wolf 1130 allows us to infer its formation and evolutionary history, which has unique implications for understanding low-mass star and brown dwarf formation around intermediate mass stars.

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Super-solar metallicity stars in the Galactic Center nuclear star cluster: unusual Sc, V, and Y abundances

Tuan Do[1], *Wolfgang Kerzendorf*[2], *Quinn Konopacky*[3], *Joseph M. Marcinik*[4], *Andrea Ghez*[1], *Jessica R. Lu*[5] *and Mark Morris*[1]

[1]UCLA, USA
[2]ESO, Germany
[3]UC San Diego, USA
[4]St. Vincent College, USA
[5]UC Berkeley, USA

We present adaptive-optics assisted near-infrared high-spectral resolution observations of late-type giants in the nuclear star cluster of the Milky Way. The metallicity and elemental abundance measurements of these stars offer us an opportunity to understand the formation and evolution of the nuclear star cluster. In addition, their proximity to the supermassive black hole (~ 0.5 pc) offers a unique probe of the star formation and chemical enrichment in this extreme environment. We observed two stars identified by medium spectral-resolution observations as potentially having very high metallicities. We use spectral-template fitting with the Phoenix grid and Bayesian inference to simultaneously constrain the overall metallicity, [M/H], α-element abundance [α/Fe], effective temperature, and surface gravity of these stars. We find that one of the stars has very high metallicity ([M/H] > 0.6) and the other is slightly above solar metallicity. Both Galactic Center stars have lines from scandium (Sc), vanadium (V), and yttrium (Y) that are much stronger than allowed by the Phoenix grid. We find, using the spectral synthesis code Spectroscopy Made Easy, that [Sc/Fe] may be an order of magnitude above solar. For comparison, we also observed an empirical calibrator in NGC 6791, the highest metallicity cluster known ([M/H] ~ 0.4). Most lines are well matched between the calibrator and the Galactic Center stars, except for Sc, V, and Y, which confirms that their abundances must be anomalously high in these stars. These unusual abundances, which may be a unique signature of nuclear star clusters, offer an opportunity to test models of chemical enrichment in this region.

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Observing multiple populations in globular clusters with the ESO archive: NGC 6388 reloaded

Eugenio Carretta[1] *and Angela Bragaglia*[1]

[1]INAF – Osservatorio di Astrofisica e Scienza dello Spazio di Bologna, Italy

The metal-rich and old bulge globular cluster (GC) NGC 6388 is one of the most massive Galactic GCs ($M \sim 10^6$ M$_\odot$). However, the spectroscopic properties of its multiple stellar populations rested only on 32 red giants (only seven of which observed with UVES, the remaining with GIRAFFE), given the difficulties in observing a rather distant cluster, heavily contaminated by bulge and disc field stars. We bypassed the problem using the largest telescope facility ever: the European Southern Observatory (ESO) archive. By selecting member stars identified by other programmes, we derive atmospheric parameters and the full set of abundances for 15 species from high resolution UVES spectra of another 17 red giant branch stars in NGC 6388. We confirm that no metallicity dispersion is appreciable in this GC. About 30% of stars show the primordial composition of first generation stars, about 20% present an extremely modified second generation composition, and half of the stars has an intermediate composition. The stars clearly distribute in the Al–O and Na–O planes into three discrete groups. We find substantial hints that more than a single class of polluters is required to reproduce the composition of the intermediate component in NGC 6388. In the heavily polluted component the sum Mg+Al increases as Al increases. The sum Mg+Al+Si is constant, and is the fossil record of hot H-burning at temperatures higher than about 70 MK in the first generation polluters that contributed to form multiple populations in this cluster.

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Review Paper

Mass loss of stars on the asymptotic giant branch: mechanisms, models and measurements

Susanne Höfner[1] *and Hans Olofsson*[2]

[1]Dept. of Physics and Astronomy, Uppsala University, Sweden

[2]Dept. of Space, Earth and Environment, Chalmers Univ. of Technology, Sweden

As low- and intermediate-mass stars reach the asymptotic giant branch (AGB) they have developed into intriguing and complex objects that are major players in the cosmic gas/dust cycle. At this stage, their appearance and evolution is strongly affected by a range of dynamical processes. Large-scale convective flows bring newly-formed chemical elements to the stellar surface and, together with pulsations, they trigger shock waves in the extended stellar atmosphere. There, massive outflows of gas and dust have their origin, which enrich the interstellar medium and, eventually, lead to a transformation of the cool luminous giants into white dwarfs. Dust grains forming in the upper atmospheric layers play a critical role in the wind acceleration process, by scattering and absorbing stellar photons and transferring their outward-directed momentum to the surrounding gas through collisions. Recent progress in high-angular-resolution instrumentation, from the visual to the radio regime, is leading to valuable new insights into the complex dynamical atmospheres of AGB stars and their wind-forming regions. Observations are revealing asymmetries and inhomogeneities in the photospheric and dust-forming layers which vary on time-scales of months, as well as more long-lived large-scale structures in the circumstellar envelopes. High-angular-resolution observations indicate at what distances from the stars dust condensation occurs, and they give information on the chemical composition and sizes of dust grains in the close vicinity of cool giants. These are essential constraints for building realistic models of wind acceleration and developing a predictive theory of mass loss for AGB stars, which is a crucial ingredient of stellar and galactic chemical evolution models. At present, it is still not fully possible to model all of these phenomena from first principles, and to predict the mass-loss rate based on fundamental stellar parameters only. However, much progress has been made in recent years, which is described in this review. We complement this by discussing how observations of emission from circumstellar molecules and dust can be used to estimate the characteristics of the mass loss along the AGB, and in different environments. We also briefly touch upon the issue of binarity.

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Job Adverts

2-year postdoctoral position in the field of observations of evolved stars at K.U. Leuven, Belgium

We seek a postdoc for the ERC Consolidator Grant AEROSOL (2016–2020, PI. Prof. Leen Decin). The project aims to boost our understanding of the physics and chemistry characterising stellar winds around evolved stars, building on observations, theoretical wind models, and laboratory experiments (fys.kuleuven.be/ ster/Projects/aerosol). The candidate will work closely with astrophysicists, chemists, and computational mathematicians. The postdoc will work on reduction, analysis and (radiative transfer) modelling of UV-mm observations, to retrieve geometrical, thermodynamical and chemical structures of stellar winds. The postdoc preferentially has experience with IR-(sub)mm observations and implementing and exploiting (radiative transfer) models to retrieve stellar wind properties. The candidate will have access to observational data, radiative transfer and forward chemistry modelling tools and possibility to develop own (hydro)simulations.

The contract runs over 2 years (with a possible prolongation of 6 months). Preferred starting date is 1 July 2018, but will be adapted to the candidate's availability. The candidate must have Ph.D. degree in astrophysics, (theoretical) physics or (applied) mathematics.

The application must be sent as one single pdf document including:

- CV (incl publication list)
- Statement of research interests and future plans (max 3 pages)
- Letter detailing your specific qualifications for the position and your career/educational goals (max 1 page)
- Contact details of 2 references prepared to send confidential recommendation letters when asked

The application should be sent by e-mail to clio.gielen@kuleuven.be with subject "PD-OBS-AEROSOL-applicantname" at the latest by April 15th 2018.

More info on fys.kuleuven.be/ster/vacancies

See also https://fys.kuleuven.be/ster/vacancies#PD_OBS_AEROSOL

2-year postdoctoral position in the field of theoretical models for evolved stars at K.U. Leuven, Belgium

We seek a postdoc to play a key role in the interdisciplinary ERC Consolidator Grant AEROSOL (2016–2020, PI. Prof. Leen Decin), focusing on stellar winds around evolved (low-mass) stars. The candidate will interact closely with other team members and departments of mathematics and chemistry, as the goal of the project is to boost our understanding of the physics and chemistry characterising stellar winds. The project builds upon novel data (including ALMA, *Herschel*), detailed theoretical wind models, and targeted laboratory experiments (fys.kuleuven.be/ster/Projects/aerosol). We seek a postdoc with expertise in theoretical and numerical modelling (within an astrophysical context). The goal of the project is to develop a dynamical forward chemistry model for stellar winds coupling the effects of hydrodynamics, thermodynamics, chemistry, and radiative transfer. Different numerical modules are already available.

The contract runs over 2 years (with a possible prolongation of 6 months). Preferred starting date is 1 July 2018, but will be adapted to the candidate's availability. The candidate must have a Ph.D. degree in astrophysics, (theoretical) physics or (applied) mathematics.

The application must be sent as one single pdf document including:

- CV (including publication list).
- Statement of research interests and future plans (max 3 pages).
- Letter detailing your specific qualifications for the position and your career/educational goals (max 1 page).
- Contact details of two references prepared to send confidential recommendation letters when asked.

The application should be sent by e-mail to clio.gielen@kuleuven.be with subject "PD-THEORY-AEROSOL-applicantname" at the latest by April 15th 2018.

More info: fys.kuleuven.be/ster/vacancies

See also https://fys.kuleuven.be/ster/vacancies#PD_THEORY_AEROSOL

Announcements

Fizeau exchange visitors program call for applications; Deadline March 15

The Fizeau exchange visitors program in optical interferometry funds (travel and accommodation) visits of researchers to an institute of his/her choice (within the European Community) to perform collaborative work and training on one of the active topics of the European Interferometry Initiative. The visits will typically last for one month, and strengthen the network of astronomers engaged in technical, scientific and training work on optical/infrared interferometry. The program is open for all levels of astronomers (Ph.D. students to tenured staff), with priority given to Ph.D. students and young postdocs. Non-EU based missions will only be funded if considered essential by the Fizeau Committee. Applicants are strongly encouraged to seek also partial support from their home or host institutions.

The deadline for applications is March 15. Fellowships can be awarded for missions to be carried out between May 2018 and October 2018!

Note: requests for support for the Fizeau school in July 2018 are NOT part of this call. Such requests will be handled by the school organizers.

Further informations and application forms can be found at www.european-interferometry.eu

The program is funded by OPTICON/H2020.

Please distribute this message also to potentially interested colleagues outside of your community!

Looking forward to your applications,
Josef Hron & Péter Ábrahám
(for the European Interferometry Initiative)

See also www.european-interferometry.eu

Laboratory Astrophysics Division Meeting of the American Astronomical Society

Abstract submission (and registration) for the 2018 Laboratory Astrophysics Division meeting, held with the 232$^{\text{th}}$ American Astronomical Society meeting (June 3–7$^{\text{th}}$, 2018, in Denver, CO) is open!

Important Deadlines

- February 26 – Early Registration
- March 5 – Abstracts due
- March 26 – Regular Registration
- May 10 – Hotel Reservations

The LAD meeting will begin in the morning of Monday June 4$^{\text{th}}$ and end with a morning session on Thursday June 7$^{\text{th}}$, with morning and afternoon sessions Monday through Wednesday. There will also be a LAD plenary talk on Tuesday morning by Prof. David Neufeld of Johns Hopkins University overviewing the exciting results obtained by the *Herschel* Space Observatory with a focus on the importance of laboratory astrophysics to our evolving understanding the of interstellar medium.

Session topics & confirmed invited speakers include:

From Data to Models:

- Jonas Lippuner (CalTech)
- Simon Glover (Univ. of Heidelberg)

Disks and Circumstellar Outflows in the ALMA Era:

- Colette Salyk (Vassar College)
- Sabrina Gärtner (Open Univ.)
- Jeremy Goodman (Princeton)

Plasma Processes in the X-ray and Beyond:

- Hiroya Yamaguchi (NASA GSFC)
- Duane Liedahl (LLNL)

Disks and Circumstellar Outflows in the JWST Era:

- Uma Gorti (NASA ARC/SETI)
- Jiao He (Syracuse Univ.)
- Timothy Lee (NASA ARC)

Mega-Lab Studies of Astro-micro-physics:

- José Crespo López-Urrutia (MPI for Nuclear Physics)
- Hendrik Schatz (Michigan State Univ.)

Cassini's view on the Chemistry of the Saturn System:

- Sarah Horst (Johns Hopkins Univ.)
- Veronique Vuitton (CNRS/Univ. Grenoble)
- Delphine Nna-Mvondo (NASA GSFC)

Neutron Star Mergers and the r-Process:

- Jennifer Barnes (Columbia Univ.)
- Rebecca Surman (Univ. Notre Dame)
- Aimee Hungerford (LANL)

This will also be your chance to meet, hear, and congratulate the LAD prize winners for 2018:

- Prof. Michael Wiescher (LAD Prize)
- Dr. Clayton Myers (LAD Dissertation Prize)

There will be a LAD Business Meeting Tuesday evening after the poster session. Refreshments will be available!

Room has been left in the schedule for some contributed talks and of course, we invite everyone to submit posters. So please plan to attend and present your latest results at what will be one of top meetings for Laboratory Astrophysics in 2018!

For the LAD Executive Committee,
Phillip Stancil
Vice-chair
Laboratory Astrophysics Division
American Astronomical Society

See also https://aas.org/meetings/aas232

IAU Call to Stand for Elections of Commission Organising Committee members (2018–2021)

Dear members of IAU Commission H4 (Star Clusters):

Every three years the IAU holds elections to name new officers for Commissions and Divisions. This will take place in April.

At this stage we are calling for nominations for membership of the CH4 Organising Committee (OC) and also nominations for the role of Vice-President. Note that in normal circumstances the Vice-President becomes President three years after election to the VP role. In our case, our current VP Amanda Karakas will take over the role as President.

In our Commission, we need to recruit three (3) new Organising Committee members and a new Vice-President (VP).

You should have received a link on February 15th from the IAU Secretariat with instructions and links to submit your interest to run.

You may nominate yourself or someone else.

Please feel free to contact Amanda Karakas (amanda.karakas@monash.eduy) directly if you have any questions!

Conference "Spectroscopy of Exoplanets" 8–11 July 2018, Cumberland Lodge, Windsor Great Park, UK

In July this year, we will be holding a conference 'Spectroscopy of Exoplanets' at Cumberland Lodge near to London. The conference will begin in the afternoon on Sunday 8 July with departure after lunch on Wednesday 11 July 2018.

Provisional topics include:
Spectroscopy of atmospheres of exoplanets; Molecules in stellar and Galactic context; Sources of opacity data (theoretical and laboratory); Characterising exoplanetary atmospheres; Observational issues; Chemistry and structure of exoplanets; Direct imaging; Cloud formation; Advances in understanding brown dwarf atmospheres.

We have gaps for 20 minute talks and posters if you want to present work.

Location:
Cumberland Lodge is a 17th Century house in beautiful parkland. The location of Cumberland Lodge offers easy access to Heathrow and is close to Windsor Castle.

You will find further details including: a registration form, details of payments and abstract submissions on the Conference website.

See also http://www.exomol.com/conferences/ExoMol2018/