THE AGB NEWSLETTER

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Editors: Jacco van Loon, Ambra Nanni and Albert Zijlstra

Figure 1: The planetary nebula Henize 2-111, suggested by Sakib Rasool and imaged by Don Goldman – see http://astrodonimaging.com/gallery/henize-2-111/ for details. It resembles the H II region N119 in the centre of the Large Magellanic Cloud. Sakib welcomes suggestions for other objects to be imaged by their team – write to sakibrasool@yahoo.co.uk

Editorial

Dear Colleagues,

It is a pleasure to present you the 244^{th} issue of the AGB Newsletter. IRC 10°420 and the Magellanic Clouds seem popular, and there's also a large number of papers on more fundamental data such as oscillator strengths, molecular line lists, helium burning treatment, determination of temperatures or variability amplitudes...

We would like to highlight the proceedings paper by John Percy on using variable red giants as a tool for education, and would encourage you all to consider the educational and public outreach potential of our research.

There is a job opening for a postdoctoral researcher in Brussels.

The European Week of Astronomy and Space Science (EWASS) takes place in Liverpool (UK) in April 2018, and there are *at least* two sessions of (potential) interest to our red giant star community – see the announcements at the end of the newsletter.

The next issue is planned to be distributed around the 1^{st} of December.

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

Food for Thought

This month's thought-provoking statement is:

How much nitrogen in our DNA was made inside AGB stars?

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

Lifetime measurements and oscillator strengths in singly ionised scandium and the solar abundance of scandium

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The lifetimes of 17 even-parity levels (3d5s, 3d4d, 3d6s and $4p^2$) in the region 57 743–77 837 cm^{-1} of singly ionized scandium (Sc II) were measured by two-step time-resolved laser induced fluorescence spectroscopy. Oscillator strengths of 57 lines from these highly excited upper levels were derived using a hollow cathode discharge lamp and a Fourier transform spectrometer. In addition, Hartree–Fock calculations where both the main relativistic and core-polarization effects were taken into account were carried out for both low- and high-excitation levels. There is a good agreement for most of the lines between our calculated branching fractions and the measurements of Lawler & Dakin in the region 9000–45 000 cm^{-1} for low excitation levels and with our measurements for high excitation levels in the region 23 500–63 100 cm^{-1}. This, in turn, allowed us to combine the calculated branching fractions with the available experimental lifetimes to determine semi-empirical oscillator strengths for a set of 380 E1 transitions in Sc II. These oscillator strengths include the weak lines that were used previously to derive the solar abundance of scandium. The solar abundance of scandium is now estimated to $\log \epsilon_\odot = 3.04 \pm 0.13$ using these semi-empirical oscillator strengths to shift the values determined by Scott et al. The new estimated abundance value is in agreement with the meteoritic value ($\log \epsilon_{\mathrm{met}} = 3.05 \pm 0.02$) of Lodders, Palme & Gail.

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Circumstellar ammonia in oxygen-rich evolved stars

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Context: The circumstellar ammonia (NH_3) chemistry in evolved stars is poorly understood. Previous observations and modelling showed that NH_3 abundance in oxygen-rich stars is several orders of magnitude above that predicted by equilibrium chemistry.
Aims: We would like to characterise the spatial distribution and excitation of NH_3 in the oxygen-rich circumstellar envelopes (CSEs) of four diverse targets: IK Tau, VY CMa, OH 231.8+4.2, and IRC +10°420.
Methods: We observed NH_3 emission from the ground state in the inversion transitions near 1.3 cm with the Very Large Array (VLA) and submillimetre rotational transitions with the Heterodyne Instrument for the Far-Infrared (HIFI) aboard *Herschel* Space Observatory from all four targets. For IK Tau and VY CMa, we observed NH_3 rovibrational absorption lines in the ν_2 band near 10.5 μm with the Texas Échelon Cross Échelle Spectrograph (TEXES) at the

NASA Infrared Telescope Facility (IRTF). We also attempted to search for the rotational transition within the excited vibrational state ($v_2 = 1$) near 2 mm with the IRAM 30m Telescope. Non-LTE radiative transfer modelling, including radiative pumping to the vibrational state, was carried out to derive the radial distribution of NH_3 in the CSEs of these targets.
Results: We detected NH_3 inversion and rotational emission in all four targets. IK Tau and VY CMa show blueshifted absorption in the rovibrational spectra. We did not detect vibrationally excited rotational transition from IK Tau. Spatially resolved VLA images of IK Tau and IRC +10°420 show clumpy emission structures; unresolved images of VY CMa and OH 231.8+4.2 indicate that the spatial-kinematic distribution of NH_3 is similar to that of assorted molecules, such as SO and SO_2, that exhibit localised and clumpy emission. Our modelling shows that the NH_3 abundance relative to molecular hydrogen is generally of the order of 10^{-7}, which is a few times lower than previous estimates that were made without considering radiative pumping and is at least 10 times higher than that in the carbon-rich CSE of IRC +10°216. NH_3 in OH 231.8+4.2 and IRC +10°420 is found to emit in gas denser than the ambient medium. Incidentally, we also derived a new period of IK Tau from its V-band light curve.
Conclusions: NH_3 is again detected in very high abundance in evolved stars, especially the oxygen-rich ones. Its emission mainly arises from localised spatial-kinematic structures that are probably denser than the ambient gas. Circumstellar shocks in the accelerated wind may contribute to the production of NH_3. Future mid-infrared spectroscopy and radio imaging studies are necessary to constrain the radii and physical conditions of the formation regions of NH_3.

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Hertzsprung–Russell diagram and mass distribution of barium stars

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With the availability of parallaxes provided by the *Tycho*–Gaia Astrometric Solution, it is possible to construct the Hertzsprung–Russell diagram (HRD) of barium and related stars with unprecedented accuracy. A direct result from the derived HRD is that subgiant CH stars occupy the same region as barium dwarfs, contrary to what their designations imply. By comparing the position of barium stars in the HRD with STAREVOL evolutionary tracks, it is possible to evaluate their masses, provided the metallicity is known. We used an average metallicity [Fe/H] = −0.25 and derived the mass distribution of barium giants. The distribution peaks around 2.5 $M_\odot$ with a tail at higher masses up to 4.5 $M_\odot$. This peak is also seen in the mass distribution of a sample of normal K and M giants used for comparison and is associated with stars located in the red clump. When we compare these mass distributions, we see a deficit of low-mass (1–2 $M_\odot$) barium giants. This is probably because low-mass stars reach large radii at the tip of the red giant branch, which may have resulted in an early binary interaction. Among barium giants, the high-mass tail is however dominated by stars with barium indices of less than unity, based on a visual inspection of the barium spectral line; that is, these stars have a very moderate barium line strength. We believe that these stars are not genuine barium giants, but rather bright giants, or supergiants, where the barium lines are strengthened because of a positive luminosity effect. Moreover, contrary to previous claims, we do not see differences between the mass distributions of mild and strong barium giants.

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Inflows, outflows, and a giant donor in the remarkable recurrent nova M 31N 2008-12a? – *Hubble* Space Telescope photometry of the 2015 eruption

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The recurrent nova M 31N 2008-12a experiences annual eruptions, contains a near-Chandrasekhar mass white dwarf, and has the largest mass accretion rate in any nova system. In this paper, we present *Hubble* Space Telescope (HST) WFC3/UVIS photometry of the late decline of the 2015 eruption. We couple these new data with archival HST observations of the quiescent system and *Keck* spectroscopy of the 2014 eruption. The late-time photometry reveals a rapid decline to a minimum luminosity state, before a possible recovery / re-brightening in the run-up to the next eruption. Comparison with accretion disk models supports the survival of the accretion disk during the eruptions, and uncovers a quiescent disk mass accretion rate of the order of 10^{-6} $\mathrm{M}_\odot$ yr^{-1}, which may rise beyond 10^{-5} $\mathrm{M}_\odot$ yr^{-1} during the super-soft source phase – both of which could be problematic for a number of well-established nova eruption models. Such large accretion rates, close to the Eddington limit, might be expected to be accompanied by additional mass loss from the disk through a wind and even collimated outflows. The archival HST observations, combined with the disk modeling, provide the first constraints on the mass donor; $L_\mathrm{donor} = 103^{+12}_{-11}$ $\mathrm{L}_\odot$, $R_\mathrm{donor} = 14.14^{+0.46}_{-0.47}$ $\mathrm{R}_\odot$, and $T_\mathrm{eff,\ donor} = 4890 \pm 110$ K, which may be consistent with an irradiated M 31 red-clump star. Such a donor would require a system orbital period $\gtrsim$5 days. Our updated analysis predicts that the M 31N 2008-12a WD could reach the Chandrasekhar mass in < 20 kyr.

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The Cluster AgeS Experiment (CASE). Variable stars in the field of the globular cluster M 22

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The field of the globular cluster M 22 (NGC 6656) was monitored between 2000 and 2008 in a search for variable

stars. BV light curves were obtained for 359 periodic, likely periodic, and long-term variables, 238 of which are new detections. Thirty nine newly detected variables, and 63 previously known ones are members or likely members of the cluster, including 20 SX Phe, 10 RRab and 16 RRc-type pulsators, one BL Her-type pulsator, 21 contact binaries, and 9 detached or semi-detached eclipsing binaries. The most interesting among the identified objects are V112 – a bright multimode SX Phe pulsator, V125 – a β Lyr-type binary on the blue horizontal branch, V129 – a blue/yellow straggler with a W UMa-like light curve, located halfway between the extreme horizontal branch and red giant branch, and V134 – an extreme horizontal branch object with $P = 2.33$ d and a nearly sinusoidal light curve; all four of them are proper motion (PM) members of the cluster. Among nonmembers, a $P = 2.83$ d detached eclipsing binary hosting a δ Sct-type pulsator was found, and a peculiar $P = 0.93$ d binary with ellipsoidal modulation and narrow minimum in the middle of one of the descending shoulders of the sinusoid. We also collected substantial new data for previously known variables; in particular we revise the statistics of the occurrence of the Blazhko effect in RR Lyr-type variables of M 22.

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A dearth of OH/IR stars in the Small Magellanic Cloud

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We present the results of targeted observations and a survey of 1612-, 1665-, and 1667-MHz circumstellar OH maser emission from asymptotic giant branch (AGB) stars and red supergiants (RSGs) in the Small Magellanic Cloud (SMC), using the Parkes and Australia Telescope Compact Array radio telescopes. No clear OH maser emission has been detected in any of our observations targeting luminous, long-period, large-amplitude variable stars, which have been confirmed spectroscopically and photometrically to be mid- to late-M spectral type. These observations have probed 3–4 times deeper than any OH maser survey in the SMC. Using a bootstrapping method with LMC and Galactic OH/IR star samples and our SMC observation upper limits, we have calculated the likelihood of not detecting maser emission in any of the two sources considered to be the top maser candidates to be less than 0.05%, assuming a similar pumping mechanism as the LMC and Galactic OH/IR sources. We have performed a population comparison of the Magellanic Clouds and used *Spitzer* IRAC and MIPS photometry to confirm that we have observed all high luminosity SMC sources that are expected to exhibit maser emission. We suspect that, compared to the OH/IR stars in the Galaxy and LMC, the reduction in metallicity may curtail the dusty wind phase at the end of the evolution of the most massive cool stars. We also suspect that the conditions in the circumstellar envelope change beyond a simple scaling of abundances and wind speed with metallicity.

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Discovery of a metal-poor, luminous post-AGB star that failed the third dredge-up

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Post-asymptotic giant branch (post-AGB) stars are known to be chemically diverse. In this paper we present the first observational evidence of a star that has failed the third dredge-up (TDU). J 005252.87−722842.9 is an A-type ($T_{\rm eff}$ = 8250 ± 250 K) luminous (8200 ± 700 $L_\odot$), metal-poor ([Fe/H] = −1.18 ± 0.10), low-mass ($M_{\rm initial} \approx$ 1.5–2.0 $M_\odot$) post-AGB star in the Small Magellanic Cloud. Through a systematic abundance study, using high-resolution optical spectra from UVES, we found that this likely post-AGB object shows an intriguing photospheric composition with no confirmed carbon-enhancement (upper limit of [C/Fe] < 0.50) nor enrichment of *s*-process elements. We derived an oxygen abundance of [O/Fe] = 0.29 ± 0.1. For Fe and O, we took into account the effects of non-local thermodynamic equilibrium (NLTE). We could not derive an upper limit for the nitrogen abundance as there are no useful nitrogen lines within our spectral coverage. The chemical pattern displayed by this object has not been observed in single or binary post-AGBs. Based on its derived stellar parameters and inferred evolutionary state, single star nucleosynthesis models predict that this star should have undergone TDU episodes while on the AGB and be carbon-enriched. However, our observations are in contrast with these predictions. We identify two possible Galactic analogues which are likely to be post-AGB stars, but the lack of accurate distances (hence luminosities) to these objects does not allow us to confirm their post-AGB status. If they have low luminosities then they are likely to be dusty post-RGB stars. The discovery of J 005252.87−722842.9 reveals a new stellar evolutionary channel whereby a star evolves without any third dredge-up episodes.

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The extended molecular envelope of the asymptotic giant branch star π^1 Gruis as seen by ALMA I. Large-scale kinematic structure and CO excitation properties

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The S-type asymptotic giant branch (AGB) star π^1 Gruis has a known companion at a separation of ≈ 400 au. The envelope structure, including an equatorial torus and a fast bipolar outflow, is rarely seen in the AGB phase and is particularly unexpected in such a wide binary system. Therefore a second, closer companion has been suggested, but the evidence is not conclusive. The new ALMA ^{12}CO and ^{13}CO J = 3–2 data, together with previously published ^{12}CO J = 2–1 data from the Submillimeter Array (SMA), and the ^{12}CO J = 5–4 and J = 9–8 lines observed with *Herschel*/Heterodyne Instrument for the Far-Infrared (HIFI), is modeled with the 3D non-LTE radiative transfer code SHAPEMOL. The data analysis clearly confirms the torus-bipolar structure. The 3D model of the CSE that satisfactorily reproduces the data consists of three kinematic components: a radially expanding torus with velocity

slowly increasing from 8 to 13 km s^{-1} along the equator plane; a radially expanding component at the center with a constant velocity of 14 km s^{-1}; and a fast, bipolar outflow with velocity proportionally increasing from 14 km s^{-1} at the base up to 100 km s^{-1} at the tip, following a linear radial dependence. The results are used to estimate an average mass-loss rate during the creation of the torus of 7.7×10^{-7} $M_\odot$ yr^{-1}. The total mass and linear momentum of the fast outflow are estimated at 7.3×10^{-4} $M_\odot$ and 9.6×10^{37} g cm s^{-1}, respectively. The momentum of the outflow is in excess (by a factor of about 20) of what could be generated by radiation pressure alone, in agreement with recent findings for more evolved sources. The best-fit model also suggests a $^{12}CO/^{13}CO$ abundance ratio of 50. Possible shaping scenarios for the gas envelope are discussed.

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Dense molecular clumps in the envelope of the yellow hypergiant IRC +10°420

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The circumstellar envelope of the hypergiant star IRC +10°420 has been traced as far out in SiO $J = 2$–1 as in CO $J = 1$–0 and CO $J = 2$–1, in dramatic contrast with the centrally condensed (thermal) SiO- but extended CO-emitting envelopes of giant and supergiant stars. Here, we present an observation of the circumstellar envelope in SiO $J = 1$–0 that, when combined with the previous observation in SiO $J = 2$–1, provide more stringent constraints on the density of the SiO-emitting gas than hitherto possible. The emission in SiO $J = 1$–0 peaks at a radius of $\sim 2''$ whereas that in SiO $J = 2$–1 emission peaks at a smaller radius of $\sim 1''$, giving rise to their ring-like appearances. The ratio in brightness temperature between SiO $J = 2$–1 and SiO $J = 1$–0 decreases from a value well above unity at the innermost measurable radius to about unity at radius of $\sim 2''$, beyond which this ratio remains approximately constant. Dividing the envelope into three zones as in models for the CO $J = 1$–0 and CO $J = 2$–1 emission, we show that the density of the SiO-emitting gas is comparable with that of the CO-emitting gas in the inner zone, but at least an order of magnitude higher by comparison in both the middle and outer zones. The SiO-emitting gas therefore originates from dense clumps, likely associated with the dust clumps seen in scattered optical light, surrounded by more diffuse CO-emitting interclump gas. We suggest that SiO molecules are released from dust grains due to shock interactions between the dense SiO-emitting clumps and the diffuse CO-emitting interclump gas.

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Estimating the dust production rate of carbon stars in the Small Magellanic Cloud

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We employ newly computed grids of spectra reprocessed by dust for estimating the total dust production rate (DPR) of carbon stars in the Small Magellanic Cloud (SMC). For the first time, the grids of spectra are computed as a

function of the main stellar parameters, i.e. mass-loss rate, luminosity, effective temperature, current stellar mass and element abundances at the photosphere, following a consistent, physically grounded scheme of dust growth coupled with stationary wind outflow. The model accounts for the dust growth of various dust species formed in the circumstellar envelopes of carbon stars, such as carbon dust, silicon carbide and metallic iron. In particular, we employ some selected combinations of optical constants and grain sizes for carbon dust which have been shown to reproduce simultaneously the most relevant color–color diagrams in the SMC. By employing our grids of models, we fit the spectral energy distributions of ≈ 3100 carbon stars in the SMC, consistently deriving some important dust and stellar properties, i.e. luminosities, mass-loss rates, gas-to-dust ratios, expansion velocities and dust chemistry. We discuss these properties and we compare some of them with observations in the Galaxy and LMC. We compute the DPR of carbon stars in the SMC, finding that the estimates provided by our method can be significantly different, between a factor $\approx$ 2–5, than the ones available in the literature. Our grids of models, including the spectra and other relevant dust and stellar quantities, are publicly available at http://starkey.astro.unipd.it/web/guest/dustymodels.

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Are some CEMP-s stars the daughters of spinstars?

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Carbon-Enhanced Metal-Poor (CEMP)-s stars are long-lived low-mass stars with a very low iron content as well as overabundances of carbon and s-elements. Their peculiar chemical pattern is often explained by pollution from an asymptotic giant branch (AGB) star companion. Recent observations have shown that most CEMP-s stars are in binary systems, providing support to the AGB companion scenario. A few CEMP-s stars, however, appear to be single. We inspect four apparently single CEMP-s stars and discuss the possibility that they formed from the ejecta of a previous-generation massive star, referred to as the "source" star. In order to investigate this scenario, we computed low-metallicity massive-star models with and without rotation and including complete s-process nucleosynthesis. We find that non-rotating source stars cannot explain the observed abundance of any of the four CEMP-s stars. Three out of the four CEMP-s stars can be explained by a 25 $M_\odot$ source star with $v_{\rm ini} \sim 500$ km s^{-1} (spinstar). The fourth CEMP-s star has a high Pb abundance that cannot be explained by any of the models we computed. Since spinstars and AGB predict different ranges of [O/Fe] and [ls/hs], these ratios could be an interesting way to further test these two scenarios.

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ExoMol line lists XXIV: A new hot line list for silicon monohydride, SiH

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SiH has long been observed in the spectrum of our Sun and other cool stars. Computed line lists for the main isotopologues of silicon monohydride, ^{28}SiH, ^{29}SiH, ^{30}SiH and ^{28}SiD are presented. These line lists consider rotation-vibration transitions within the ground $X\,^2\Pi$ electronic state as well as transitions to the low-lying $A\,^2\Delta$ and $a\,^4\Sigma^-$ states. Ab initio potential energy (PECs) and dipole moment curves (DMCs) along with spin–orbit and electronic–angular-momentum couplings between them are calculated using the MRCI level of theory with the MOLPRO package.

The PEC for the ground $X\,^2\Pi$ state is refined to available experimental data with a typical accuracy of around 0.01 cm^{-1} or better. The ^{28}SiH line list includes 11,785 rovibronic states and 1,724,841 transitions with associated Einstein-A coefficients for angular momentum J up to 82.5 and covering wavenumbers up to 31,340 cm^{-1} ($\lambda < 0.319\ \mu m$). Spectra are simulated using the new line list and comparisons made with various experimental spectra. These line lists are applicable up to temperatures of $\sim$ 5000 K, making them relevant to astrophysical objects such as exoplanetary atmospheres and cool stars and opening up the possibility of detection in the interstellar medium. These line lists are available at the ExoMol (http:www.exomol.com) and CDS database websites.

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Laboratory experiments on the low temperature formation of carbonaceous grains in the ISM

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The life-cycle of cosmic dust grains is far from being understood and the origin and evolution of interstellar medium (ISM) grains is still under debate. In the ISM, the cosmic dust destruction rate is faster than the production rate by stellar sources. However, observations of ISM refractory matter suggest that to maintain a steady amount of cosmic grains, some supplementary production mechanism takes place. In this context, we aimed to study possible re-formation mechanisms of cosmic grains taking place at low temperature directly in the ISM. The low temperature condensation of carbonaceous materials has been investigated in experiments mimicking the ISM conditions. Gas-phase carbonaceous precursors created by laser ablation of graphite were forced to accrete on cold substrates ($T \sim 10$ K) representing surviving dust grains. The growing and evolution of the condensing carbonaceous precursors have been monitored by MIR and UV spectroscopy under a number of experimental scenarios. It is demonstrated, for the first time, the possibility to form ISM carbonaceous grains "in situ". The condensation process is governed by carbon chains that first condense into small carbon clusters and finally into more stable carbonaceous materials, which structural characteristics are comparable to the material formed in gas-phase condensation experiments at very high temperature. We also show that the so-formed fullerene-like carbonaceous material is transformed into a more ordered material under VUV processing. The cold condensation mechanisms here discussed can give fundamental clues to fully understand the balance between the timescale for dust injection, destruction and re-formation in the ISM.

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A symbiotic channel for the progenitors of type Ia supernovæ

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The companions of the exploding carbon–oxygen white dwarfs (CO WDs) for producing type Ia supernovæ (SNe Ia) are still not conclusively confirmed. A red-giant (RG) star has been suggested to be the mass donor of the exploding WD, known as the symbiotic channel. However, previous studies on the symbiotic channel gave a relatively low rate of SNe Ia. In this Letter, we adopted an integrated mass-transfer prescription that is applicable for the mass-transfer from a RG star onto the WD. In this prescription, the mass-transfer rate varies with the local material states. We evolved a large number of WD+RG systems, and found that the parameter space of WD+RG systems for producing SNe Ia is significantly enlarged. This channel could produce SNe Ia with intermediate and old ages, contributing to 2–5% of all SNe Ia in our Galaxy. We suggest that the symbiotic systems RS Oph and T CrB are strong candidates for the progenitors of SNe Ia.

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Method to estimate the effective temperatures of late-type giants using line-depth ratios in the wavelength range 0.97–1.32 μm

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The effective temperature, one of the most fundamental atmospheric parameters of a star, can be estimated using various methods, and here we focus on the method using line-depth ratios (LDRs). This method combines low- and high-excitation lines and makes use of relations between LDRs of these line pairs and the effective temperature. It has an advantage, for example, of being minimally affected by interstellar reddening, which changes stellar colours. We report 81 relations between LDRs and the effective temperature established with high-resolution, $\lambda/\Delta\lambda \sim 28,000$, spectra of nine G- to M-type giants in Y and J bands. Our analysis gives the first comprehensive set of LDR relations for this wavelength range. The combination of all these relations can be used to determine the effective temperatures of stars that have $3700 < T_{\rm eff} < 5400$ K and $-0.5 < $ [Fe/H] $< +0.3$ dex to the precision of ± 10 K in the best cases.

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Amplitude variations in pulsating red giants. II. Some systematics

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In order to extend our previous studies of the unexplained phenomenon of cyclic amplitude variations in pulsating red giants, we have used the AAVSO time-series package VSTAR to analyze long-term AAVSO visual observations of 50 such stars, mostly Mira stars. The relative amount of the variation, typically a factor of 1.5, and the time scale

of the variation, typically 20–35 pulsation periods, are not significantly different in longer-period, shorter-period, and carbon stars in our sample, and they also occur in stars whose period is changing secularly, perhaps due to a thermal pulse. The time scale of the variations is similar to that in smaller-amplitude SR variables, but the relative amount of the variation appears to be larger in smaller-amplitude stars, and is therefore more conspicuous. The cause of the amplitude variations remains unclear, though they may be due to the rotational modulation of a star whose pulsating surface is dominated by the effects of large convective cells.

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Fe I oscillator strengths for transitions from high-lying odd-parity levels

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We report new experimental Fe I oscillator strengths obtained by combining measurements of branching fractions measured with a Fourier Transform spectrometer and time-resolved laser-induced fluorescence lifetimes. The study covers the spectral region ranging from 213 to 1033 nm. A total of 120 experimental $\log gf$-values coming from 15 odd-parity energy levels are provided, 22 of which have not been reported previously and 63 values with lower uncertainty than the existing data. Radiative lifetimes for 60 upper energy levels are presented, 39 of which have no previous measurements.

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Radiation forces on dust envelopes

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We address in detail the radiation forces on spherical dust envelopes around luminous stars, and numerical solutions for these forces, as a first step toward more general dust geometries. Two physical quantities, a normalized force and a force-averaged radius, suffice to capture the overall effects of radiation forces. In addition to the optically thin and thick regimes, the wavelength dependence of dust opacity allows for an intermediate case in which starlight is easily trapped but infrared radiation readily escapes. Scattering adds a non-negligible force in this intermediate regime. We address all three regimes analytically and provide approximate formulæ for the force parameters, for arbitrary optical depth and inner dust temperature. Turning to numerical codes, we examine the convergence properties of DUSTY and of the Monte Carlo code HYPERION. We find that Monte Carlo codes tend to underestimate the radiation force when the mean free path of starlight is not well resolved, as this causes the inner dust temperature, and therefore the inner Rosseland opacity, to be too low. We briefly discuss implications for more complicated radiation transfer problems.

Submitted to MNRAS
Available from https://arxiv.org/abs/1710.09424

Computational method for a fractional model of the helium burning network

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Stellar cores may be considered as a nuclear reactor that play important role in injecting new synthesized elements in the interstellar medium helium burning is an important stage that contribute to the synthesis of key elements such as carbon, through the triple-α process, and oxygen. In the present paper, we introduce a computational method for the fractional model of the nuclear helium burning in stellar cores. The system of fractional differential equations is solved simultaneously using series expansion method. The calculations are performed in the sense of modified Riemann–Liouville fractional derivative. Analytic expressions are obtained for the abundance of each element as a function of time. Comparing the abundances calculated at the fractional parameter $\alpha = 1$, which represents the integer solution, with the numerical solution revealed a good agreement with maximum error $\epsilon = 0.003$. The product abundances are calculated at $\alpha = 0.25$, 0.5, 0.75 to declare the effects of changing the fractional parameters on the calculations.

Submitted to Astronomy Reports
Available from https://arxiv.org/abs/1710.08459

Detailed abundances for the old population near the Galactic Center I. Metallicity distribution of the nuclear star cluster

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We report the first high spectral resolution study of 17 M giants kinematically confirmed to lie within a few parsecs of the Galactic Center, using $R \sim 24,000$ spectroscopy from *Keck*/NIRSPEC and a new linelist for the infrared K band. We consider their luminosities and kinematics, which classify these stars as members of the older stellar population and the central cluster. We find a median metallicity of $\langle[\mathrm{Fe/H}]\rangle = -0.16$ and a large spread from approximately -0.3 to $+0.3$ (quartiles). We find that the highest metallicities are $[\mathrm{Fe/H}] < 0.6$, with most of the stars being at or below the Solar iron abundance. The abundances and the abundance distribution strongly resembles that of the Galactic bulge rather than disk or halo; in our small sample we find no statistical evidence for a dependence of velocity dispersion on metallicity.

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Available from https://arxiv.org/abs/1710.08477

Conference Papers

Maser, infrared and optical emission for late-type stars in the Galactic plane

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Radio astrometric campaigns using VLBI have provided distances and proper motions for masers associated with young massive stars (BeSSeL survey). The ongoing BAaDE project plans to obtain astrometric information of SiO maser stars located in the inner Galaxy. These stars are associated with evolved, mass-losing stars. By overlapping optical (Gaia), infrared (2MASS, MSX and WISE) and radio (BAaDE) sources, we expect to obtain important clues on the intrinsic properties and population distribution of late-type stars. Moreover, a comparison of the Galactic parameters obtained with Gaia and VLBI can be done using radio observations on different targets: young massive stars (BeSSeL) and evolved stars (BAaDE).

Available from https://arxiv.org/abs/1710.05441

Forty years of linking variable star research with education

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In this review, I reflect on four decades of my experience in linking astronomy research and education by supervising variable-star research projects by undergraduates, and by outstanding senior high school students. I describe the evolution of my experience, the students I have supervised, the nature of their projects, the educational contexts of their projects, the need for "best practices", the journals in which we publish, and the special role of the American Association of Variable Star Observers (AAVSO). I then describe our recent research on pulsating red giants and related objects, including three astrophysical mysteries that we have uncovered. Finally, I suggest how my projects might be scaled up or extended by others who supervise student research.

Oral contribution, published in "Remote Telescopes, Student Research, and Education"
Available from https://arxiv.org/abs/1710.04492

Job Advert

Postdoctoral position

This position is situated within the framework of the STARLAB BRAINbe network (http://www.astro.ulb.ac.be/pmwiki/BRAIN/HomePage) financed by BELSPO. The network is a collaboration between the Royal Observatory of Belgium (ROB – M. Groenewegen), the astronomy department of the ULB (Prof. A. Jorissen, the principal investigator of STARLAB), and the astronomy department of the K.U. Leuven (Prof. C. Wælkens). One of the three workpackages within STARLAB aims at a better understanding of the mass-loss process in late-type stars, analysing data from the *Herschel* satellite, and the ALMA interferometer. This workpackage is a collaboration between ROB and K.U. Leuven (Prof. L. Decin).

WE LOOK FOR A PERSON (M/F):

- Holding a doctoral degree in astrophysics (at the time of the start of the contract).
- Knowledge of dust continuum and/or molecular line radiative transfer modelling.
- A background in stellar astrophysics and evolved star research would be an advantage.
- Good command of the English language.
- Motivated and flexible researcher.
- Good team-player within the STARLAB network.

WE OFFER:

- A contract for at most 13 months, depending on the personal situation and work experience.
- Salary and social security benefits according to federal regulations for civil servants at the SW1 level.
- Flexible working hours.
- Refund of commuting expenses with public transport or bicycle.

HOW TO APPLY:
Candidates must send a motivation letter and CV (in English), at least one letter of reference, and an electronic copy of their Ph.D. thesis, to Dr. Groenewegen (martin.groenewegen@oma.be). The application deadline is December 15$^{\mathrm{th}}$, 2017. Interviews may be held early 2018. The position would start in the Spring of 2018.

Announcements

Special Session at EWASS 2018
Dust formation by evolved stars and supernovæ

We would like to draw your attention to an EWASS Special Session on "Dust formation by evolved stars and supernovæ", which will take place during April 3–6 2018 in Liverpool. During this meeting, we are hoping to bring observers and modellers together to re-evaluate the efficiency of dust formation processes in evolved stars and supernova remnants. The deadline for final abstract submission is at the end of this month (November 27 2017) so please do not hesitate to submit your abstracts to present your work at this meeting!

We look forward to a fruitful meeting in Liverpool with plenty of interesting discussions and new ideas!

Confirmed invited speakers:
Sara Bladh – Jacco van Loon – Mike Barlow

SOC:
Ilse De Looze (Chair) – Olivia C. Jones – Ambra Nanni – Elvire De Beck – Leen Decin – Arkaprabha Sarangi – Stefania Marassi

See also http://eas.unige.ch/EWASS2018/session.jsp?id=SS6

Special Session at EWASS 2018:
Atomic and molecular data needs for astronomy and astrophysics

The aim of this session is to encourage further dialogue and promote knowledge transfer between astronomers with strong atomic and molecular data needs and those who produce this data from laboratory measurements and calculations. We hope this will foster new collaborations for the future, which, through targeted measurements and calculations, will accelerate the rate at which astronomers' needs can be met.

Talks and posters will focus on four main areas:

- Data requirements of astronomers
- Laboratory-measured atomic and molecular data
- Theoretical calculations
- Databases

We encourage all astronomers involved in the ongoing spectroscopic surveys such as Gaia–ESO, APOGEE or GALAH or in future ones such as WEAVE, 4MOST or DESI to attend in order to explain their data needs.

The emphasis throughout the special session will remain on knowledge transfer; with astronomers highlighting their data needs, and spectroscopists and theorists presenting new data of astronomical interest and the capabilities of their facilities for future collaborations.

See also http://eas.unige.ch/EWASS/session.jsp?year=2018&id=SS4