# THE AGB NEWSLETTER

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Editors: Jacco van Loon, Ambra Nanni and Albert Zijlstra

## *Editorial*

Dear Colleagues,

It is our pleasure to present you the 231$^{st}$ issue of the AGB Newsletter. The Gaia first data release is out, so we're sure some of you will be frantically working on that. A related paper is featured in this issue and we're expecting some papers based on actual Gaia data to appear in the next one (one had appeared on arXiv just in the past few days).

Someone responded to last month's 'Food for Thought', *What do long secondary periods really measure?*
"Probably the same as do short secondary periods - unless the question contains a 'double entendre' which is only obvious to certain people (smile). There is no physical distinction between long secondary periods and short ones – it is an observational bias that leads one to rate those about which we know most as 'the norm'. The plain fact is that observers – researchers – robotic programmes – have not continued long enough to realize that there is a continuous distribution of periods from very short to centuries long. At IAU S287, 'New Horizons in Time-Domain Astronomy', Professor Roger Griffin demonstrated how to measure – actually measure – periods of the order of one century, but it had taken even him many decades to gather enough high-quality observations. He only measures primary periods, but if the object is a binary then it will have a secondary period of the same length. In a non-astrophysical context, therefore, 'long secondary periods' measure determination, persistence, advances in technology, and plain old age (of the observer), or a long-lasting team of the kind that no institution likes to support financially."
Reactions to the above or this month's 'Food for Thought' are very welcome and will be posted in the editorial as usual.

If you know of any good Ph.D. candidate students, please bring to their attention the opportunities offered in Göttingen (a very nice place with a superb group of astronomers).

Do read the short announcement from the ExoMol group. They are interested in feedback and suggestions, so if your favourite molecule does not have spectroscopic data that's up to scratch: let them know!

Finally, if you fancy science on the beach then SN 1987A on La Réunion might be for you.

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

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

## *Food for Thought*

This month's thought-provoking statement is:

*How can we overcome the limitations of Gaia for the study of the coolest red giant 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

## The millimeter IRAM-30m line survey toward IK Tau

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We carried out a millimeter wavelength line survey between 79 and 356 GHz with the IRAM-30m telescope to investigate the physical and chemical properties of the molecular envelope of the oxygen-rich AGB star IK Tau. We analysed the molecular lines detected using the population diagram technique to derive rotational temperatures and column densities. Additionally, we conducted a radiative transfer analysis of the $SO_2$ lines detected. For the first time in this source we detected rotational lines in the ground vibrational state of $HCO^+$, NS, NO, and $H_2CO$, as well as several isotopologues of molecules previously identified. We also detected several rotational lines in vibrationally excited states of SiS and SiO isotopologues, and rotational lines of $H_2O$ ($\nu_2 = 2$). We have also increased the number of rotational lines detected of molecules that were previously identified, enabling a detailed study of the molecular abundances and excitation temperatures. IK Tau displays a rich chemistry for an oxygen-rich circumstellar envelope. We highlight the detection of NS and $H_2CO$ with fractional abundances of $f(\mathrm{NS}) \sim 10^{-8}$ and $f(\mathrm{H_2CO}) \sim [10^{-7}$–$10^{-8}]$. Most of the molecules display rotational temperatures between 15 and 40 K. NaCl and SiS isotopologues display rotational temperatures higher than the average ($\sim$ 65 K). In the case of $SO_2$ a warm component with $T_{\mathrm{rot}} \sim 290$ K is also detected. This $SO_2$ warm component is probably arising from the inner regions of the envelope (at $\sim 8$ $R_\star$) where $SO_2$ has a fractional abundance of $f(\mathrm{SO_2}) \sim 10^{-6}$. This result should be considered for future investigation of the main formation channels of this, and other, parent species in the inner winds of O-rich AGB stars, which at present are not well reproduced by current chemistry models.

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*Available from* http://arxiv.org/abs/1609.01904
*and from* http://dx.doi.org/10.1051/0004-6361/201628776

## IFU spectroscopy of southern planetary nebulæ – III

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In this paper, we describe integral field spectroscopic observations of four southern Galactic planetary nebulæ (PNe), M 3-4,M 3-6, Hen 2-29 and Hen 2-37 covering the spectral range 3400–7000 Å. We derive the ionization structure, the physical conditions, the chemical compositions and the kinematical characteristics of these PNe and find good agreement with previous studies that relied upon the long-slit technique in their co-spatial area. From their chemical compositions as well as their spatial and kinematic characteristics, we determined that Hen 2-29 is of the Peimbert type I (He- and N-rich), while the other three are of type II. The strength of the nebular He II line reveals that M 3-3, Hen 2-29 and Hen 2-37 are of mid to high excitation classes while M 3-6 is a low-excitation PN. A series of emission-line maps extracted from the data cubes were constructed for each PN to describe its overall structure. These show remarkable morphological diversity. Spatially resolved spectroscopy of M 3-6 shows that the recombination lines of C II, C III, C IV and N III are of nebular origin, rather than arising from the central star as had been previously proposed. This result increases doubts regarding the weak emission-line star (WELS) classification raised by Basurah et al. In addition, they reinforce the probability that most genuine cases of WELS arise from irradiation effects in close binary central stars.

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## The fates of Solar system analogues with one additional distant planet

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The potential existence of a distant planet ("Planet Nine") in the Solar system has prompted a re-think about the evolution of planetary systems. As the Sun transitions from a main sequence star into a white dwarf, Jupiter, Saturn, Uranus and Neptune are currently assumed to survive in expanded but otherwise unchanged orbits. However, a sufficiently-distant and sufficiently-massive extra planet would alter this quiescent end scenario through the combined effects of Solar giant branch mass loss and Galactic tides. Here, I estimate bounds for the mass and orbit of a distant extra planet that would incite future instability in systems with a Sun-like star and giant planets with masses and orbits equivalent to those of Jupiter, Saturn, Uranus and Neptune. I find that this boundary is diffuse and strongly dependent on each of the distant planet's orbital parameters. Nevertheless, I claim that instability occurs more often than not when the planet is as massive as Jupiter and harbours a semimajor axis exceeding about 300 au, or has a mass of a super-Earth and a semimajor axis exceeding about 3000 au. These results hold for orbital pericentres ranging from 100 to at least 400 au. This instability scenario might represent a common occurrence, as potentially evidenced by the ubiquity of metal pollution in white dwarf atmospheres throughout the Galaxy.

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## The evolution and fate of super-Chandrasekhar mass white dwarf merger remnants

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We present stellar evolution calculations of the remnant of the merger of two carbon–oxygen white dwarfs (CO WDs). We focus on cases that have a total mass in excess of the Chandrasekhar mass. After the merger, the remnant manifests as an $L \sim 3 \times 10^4$ $L_\odot$ source for $\sim 10^4$ yr. A dusty wind may develop, leading these sources to be self-obscured and to appear similar to extreme AGB stars. Roughly $\sim 10$ such objects should exist in the Milky Way and M 31 at any time. As found in previous work, off-center carbon fusion is ignited within the merger remnant and propagates inward via a carbon flame, converting the WD to an oxygen–neon (ONe) composition. By following the evolution for longer than previous calculations, we demonstrate that after carbon-burning reaches the center, neutrino-cooled Kelvin–Helmholtz contraction leads to off-center neon ignition in remnants with masses $\geq 1.35$ $M_\odot$. The resulting neon–oxygen flame converts the core to a silicon WD. Thus, super-Chandrasekhar WD merger remnants do not undergo electron-capture induced collapse as traditionally assumed. Instead, if the remnant mass remains above the Chandrasekhar mass, we expect that it will form a low-mass iron core and collapse to form a neutron star. Remnants that lose sufficient mass will end up as massive, isolated ONe or Si WDs.

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# Characterisation of red supergiants in the Gaia spectral range

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The infrared Calcium Triplet and its nearby spectral region have been used for spectral and luminosity classification of late-type stars, but the samples of cool supergiants (CSGs) used have been very limited (in size, metallicity range, and spectral types covered). The spectral range of the Gaia Radial Velocity Spectrograph (RVS) covers most of this region but does not reach the main TiO bands in this region, whose depths define the M sequence. We study the behaviour of spectral features around the Calcium Triplet and develop effective criteria to identify and classify CSGs, comparing their efficiency with other methods previously proposed. We measure the main spectral features in a large sample (almost 600) of CSGs from three different galaxies, and we analyse their behaviour through a principal component analysis. Using the principal components, we develop an automatised method to differentiate CSGs from other bright late-type stars, and to classify them. The proposed method identifies a high fraction of the supergiants (SGs) in our test sample, which cover a wide metallicity range (SGs from the SMC, the LMC, and the Milky Way) and with spectral types from G0 up to late-M. In addition, it is capable to separate most of the non-SGs in the sample, identifying as SGs only a very small fraction of them. A comparison of this method with other previously proposed shows that it is more efficient and selects less interlopers. A way to automatically assign a spectral type to the SGs is also developed. We apply this study to spectra at the resolution and spectral range of the Gaia RVS, with a similar success rate. The method developed identifies and classifies CSGs in large samples, with high efficiency and low contamination, even in conditions of wide metallicity and spectral-type ranges.

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# Chlorine abundances in cool stars

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Chlorine abundances are reported in 15 evolved giants and one M dwarf in the solar neighborhood. The Cl abundance was measured using the vibration-rotation 1–0 P8 line of $H^{35}Cl$ at 3.69851 $\mu$m. The high resolution L-band spectra were observed using the Phoenix infrared spectrometer on the Kitt Peak Mayall 4m telescope. The average $[^{35}Cl/Fe]$ abundance in stars with $-0.72 < [Fe/H] < 0.20$ is $[^{35}Cl/Fe] = -0.10 \pm 0.15$ dex. The mean difference between the $[^{35}Cl/Fe]$ ratios measured in our stars and chemical evolution model values is $0.16 \pm 0.15$ dex. The $[^{35}Cl/Ca]$ ratio has an offset of $\sim 0.35$ dex above model predictions suggesting chemical evolution models are under producing Cl at the high metallicity range. Abundances of C, N, O, Si, and Ca were also measured in our spectral region and are consistent with F and G dwarfs. The Cl versus O abundances from our sample match Cl abundances measured in planetary nebula and H II regions. In one star where both $H^{35}Cl$ and $H^{37}Cl$ could be measured, a $^{35}Cl/^{37}Cl$ isotope ratio of $2.2 \pm 0.4$ was found, consistent with values found in the Galactic ISM and predicted chemical evolution models.

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## High-resolution Very Large Array observations of 18 MIPSGAL bubbles

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We present radio observations of 18 MIPSGAL bubbles performed at 5 GHz (6 cm) with the Karl G. Jansky Very Large Array in configuration B and BnA. The observations were aimed at understanding what kind of information high-resolution and high-sensitivity radio maps can supply on the circumstellar envelopes of different kinds of evolved stars and what their comparison with infrared images with similar resolution can tell us. We found that the 18 bubbles can be grouped into five categories according to their radio morphology. The three bubbles presenting a central point source in the radio images all correspond to luminous blue variable star candidates. Eleven bubbles show an elliptical shape and the total lack of a central object in the radio, and are likely associated with planetary nebulæ. Under this assumption we derive their distance, their ionized mass and their distribution on the Galactic plane. We discuss the possibility that the MIPSGAL bubbles catalogue (428 objects) may contain a large fraction of all Galactic planetary nebulæ located at a distance between 1.4 kpc and 6.9 kpc and lying in the MIPSGAL field of view. Among the remaining bubbles we identify also a H II region and a proto-planetary nebula candidate.

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## Optimal fitting of Gaussian-apodized or under-resolved emission lines in Fourier Transform spectra providing new insights on the velocity structure of NGC 6720

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An analysis of the kinematics of NGC 6720 is performed on the commissioning data obtained with SITELLE, the Canada–France–Hawai'i Telescope's new imaging Fourier transform spectrometer. In order to measure carefully the small broadening effect of a shell expansion on an unresolved emission line, we have determined a computationally robust implementation of the convolution of a Gaussian with a sinc instrumental line shape which avoids arithmetic overflows. This model can be used to measure line broadening of typically a few km s$^{-1}$ even at low spectral resolution ($R < 5000$). We have also designed the corresponding set of Gaussian apodizing functions that are now used by ORBS, the SITELLE's reduction pipeline. We have implemented this model in ORCS, a fitting engine for SITELLE's data, and used it to derive the [S II] density map of the central part of the nebula. The study of the broadening of the [N II] lines shows that the Main Ring and the Central Lobe are two different shells with different expansion velocities. We have also derived deep and spatially resolved velocity maps of the Halo in [N II] and H$\alpha$ and found that the brightest bubbles are originating from two bipolar structures with a velocity difference of more than 35 km s$^{-1}$ lying at the poles of a possibly unique Halo shell expanding at a velocity of more than 15 km s$^{-1}$.

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## Formation and evolution of blue stragglers in 47 Tucanæ

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Blue stragglers (BSS) are stars whose position in the Color–Magnitude Diagram (CMD) places them above the main sequence turn-off (TO) point of a star cluster. Using data from the core of 47 Tuc in the ultraviolet (UV), we have identified various stellar populations in the CMD, and used their radial distributions to study the evolution and origin of BSS, and obtain a dynamical estimate of the mass of BSS systems. When we separate the BSS into two samples by their magnitude, we find that the bright BSS show a much more centrally concentrated radial distribution and thus higher mass estimate (over twice the TO mass for these BSS systems), suggesting an origin involving triple or multiple stellar systems. In contrast, the faint BSS are less concentrated, with a radial distribution similar to the main sequence (MS) binaries, pointing to the MS binaries as the likely progenitors of these BSS. Putting our data together with available photometric data in the visible and using MESA evolutionary models, we calculate the expected number of stars in each evolutionary stage for the normal evolution of stars and the number of stars coming from the evolution of BSS. The results indicate that BSS have a post-MS evolution comparable to that of a normal star of the same mass and a MS BSS lifetime of about 200–300 Myr. We also find that the excess population of asymptotic giant branch (AGB) stars in 47 Tuc is due to evolved BSS.

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## On the properties of dust and gas in the environs of V838 Monocerotis

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*Herschel* FIR imaging and spectroscopy were taken at several epochs to probe the central point source and the extended environment of V838 Mon. PACS and SPIRE maps were used to obtain photometry of the near and far dust around V838 Mon. Fitting reveals 0.5–0.6 $M_\odot$ of $\approx 19$ K dust in the environs ($\approx 2.7$ pc) surrounding the star. The surface-integrated infrared flux (signifying the thermal light echo) and derived dust properties do not vary significantly between the epochs. We also fit the SED of the point source. As the peak of the SED lies outside the *Herschel* spectral range, it is only by incorporating data from other observatories and epochs that we can perform useful fitting; with this we explicitly assume no evolution of the point source between the epochs. We find warm dust with a temperature of $\sim 300$ K distributed over a radius of 150–200 au. PACS and SPIRE spectra were also used to detect emission lines from the extended environment around the star. We fit the far-infrared lines of CO arising from the point source, from an extended environment around V838 Mon. Assuming a model of a spherical shell for this gas, we find that the CO appears to arise from two temperature zones: a cold zone ($T_{\rm kin} \approx 18$ K) that could be associated with the ISM or possibly with a cold layer in the outermost part of the shell, and a warm ($T_{\rm kin} \approx 400$ K) zone that is associated with the extended environment of V838 Mon within a region of radius of $\approx 210$ au. The SiO lines arise from a warm/hot zone. We did not fit the lines of $H_2O$ as they are far more dependent on the model assumed.

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## Modelling the structure and kinematics of the Firework nebula: The nature of the GK Persei nova shell and its jet-like feature

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*Aims:* The shaping mechanisms of old nova remnants are probes for several important and unexplained processes, such as dust formation and the structure of evolved star nebulæ. To gain a more complete understanding of the dynamics of the GK Per (Nova Per 1901) remnant, an examination of symmetry of the nova shell is explored, followed by a kinematical analysis of the previously detected jet-like feature in the context of the surrounding fossil planetary nebula.
*Methods:* Faint-object high-resolution échelle spectroscopic observations and imaging were undertaken covering the knots which comprise the nova shell and the surrounding nebulosity. New imaging from the Aristarchos telescope in Greece and long-slit spectra from the Manchester Échelle Spectrometer instrument at the San Pedro Mártir observatory in México were obtained, supplemented with archival observations from several other optical telescopes. Position–velocity arrays are produced of the shell, and also individual knots, and are then used for morpho–kinematic modelling with the SHAPE code. The overall structure of the old knotty nova shell of GK Per and the planetary nebula in which it is embedded is then analysed.
*Results:* Evidence is found for the interaction of knots with each other and with a wind component, most likely the periodic fast wind emanating from the central binary system. We find that a cylindrical shell with a lower velocity polar structure gives the best model fit to the spectroscopy and imaging. We show in this work that the previously seen jet-like feature is of low velocity.
*Conclusions:* The individual knots have irregular tail shapes; we propose here that they emanate from episodic winds from ongoing dwarf nova outbursts by the central system. The nova shell is cylindrical, not spherical, and the symmetry axis relates to the inclination of the central binary system. Furthermore, the cylinder axis is aligned with the long axis of the bipolar planetary nebula in which it is embedded. Thus, the central binary system is responsible for the bipolarity of the planetary nebula and the cylindrical nova shell. The gradual planetary nebula ejecta versus sudden nova ejecta is the reason for the different degrees of bipolarity. We propose that the 'jet' feature is an illuminated lobe of the fossil planetary nebula that surrounds the nova shell.

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## The mass-ratio and eccentricity distributions of barium and S stars, and red giants in open clusters

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In order to identify diagnostics distinguishing between pre- and post-mass-transfer systems, the mass-ratio distribution and period–eccentricity ($P$–$e$) diagram of barium and S stars are compared to those of the sample of binary red giants in open clusters from Mermilliod et al. (2007). From the analysis of the mass-ratio distribution for the cluster binary giants, we find an excess of systems with companion masses between 0.58 and 0.87 $M_{\odot}$, typical for white dwarfs. They represent 22% of the sample, which are thus candidate post-mass-transfer systems. Among these candidates which occupy the same locus as the barium and S stars in the ($P$–$e$) diagram, only 33% (= 4/12) show a chemical signature of mass transfer in the form of $s$-process overabundances (from rather moderate – about 0.3 dex – to more extreme – about 1 dex). These $s$-process-enriched cluster stars show a clear tendency to be in the clusters with the lowest metallicity in the sample, confirming the classical prediction that the $s$-process nucleosynthesis is more efficient at low metallicities (the only strong barium star in our sample is found in the cluster with the lowest metallicity, i.e., star 173

in NGC 2420, with [Fe/H] = −0.26). The $s$-process overabundance is not clearly correlated with the cluster turnoff (TO) mass (such a correlation would instead hint at the importance of the dilution factor). We find as well a mild barium star in NGC 2335, a cluster with a large TO mass of 4.3 $M_\odot$, which implies that intermediate-mass AGB stars still operate the $s$-process and the third dredge-up.

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## The intermediate neutron-capture process and carbon-enhanced metal-poor stars

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Carbon-enhanced metal-poor (CEMP) stars in the Galactic Halo display enrichments in heavy elements associated with either the $s$ (slow) or the $r$ (rapid) neutron-capture process (e.g., barium and europium respectively), and in some cases they display evidence of both. The abundance patterns of these CEMP-$s/r$ stars, which show both Ba and Eu enrichment, are particularly puzzling since the $s$ and the $r$ processes require neutron densities that are more than ten orders of magnitude apart, and hence are thought to occur in very different stellar sites with very different physical conditions. We investigate whether the abundance patterns of CEMP-$s/r$ stars can arise from the nucleosynthesis of the intermediate neutron-capture process (the $i$ process), which is characterised by neutron densities between those of the $s$ and the $r$ processes. Using nuclear network calculations, we study neutron capture nucleosynthesis at different constant neutron densities $n$ ranging from $10^7$ to $10^{15}$ cm$^{-3}$. With respect to the classical $s$ process resulting from neutron densities on the lowest side of this range, neutron densities on the highest side result in abundance patterns that show an increased production of heavy $s$-process and $r$-process elements but similar abundances of the light $s$-process elements. Such high values of $n$ may occur in the thermal pulses of asymptotic giant branch (AGB) stars due to proton ingestion episodes. Comparison to the surface abundances of 20 CEMP-$s/r$ stars show that our modelled $i$-process abundances successfully reproduce observed abundance patterns that could not be previously explained by $s$-process nucleosynthesis. Because the $i$-process models fit the abundances of CEMP-$s/r$ stars so well, we propose that this class should be renamed as CEMP-$i$.

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# *Conference Paper*

## The circumstellar environment of pre-SN Ia systems

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Here we explore the possible preexisting circumstellar debris of supernova type Ia systems. Classical, symbiotic and recurrent novæ all accrete onto roughly solar mass white dwarfs from main sequence or Mira type companions and

result in thermonuclear runaways and expulsion of the accreted material at high velocity. The expelled material forms a fast moving shell that eventually slows to planetary nebula expansion velocities within several hundred years. All such systems are recurrent and thousands of shells (each of about $10^{-4}$ $M_{\odot}$) snow plough into the environment. As these systems involve common envelope binaries the material is distributed in a non-spherical shell. These systems could be progenitors of some SN Ia and thus explode into environments with large amounts of accumulated gas and dust distributed in thin non-spherical shells. Such shells should be observable around 100 years after a SN Ia event in a radio flash as the SN Ia debris meets that of the ejected material of the systems previous incarnation.

**Poster contribution, published in the Supernova Remnants Conference, Chania, Greece, June 6–11 (2016)**
*Available from* http://arxiv.org/abs/1608.05016

# *Job Advert*

## Several Ph.D. positions in various areas of astrophysics

The International Max Planck Research School at the University of Göttingen in Germany offers a research-oriented doctoral programme. It is jointly run by the Max Planck Institute for Solar System Research (MPS) and the University of Göttingen. The IMPRS invites applications with a deadline of 15 November 2016.

Featured Ph.D. project to work with Saskia Hekker on Galactic structure studies:
`http://www.mps.mpg.de/phd/astrophysics-galactic-structure`

More projects at `http://www.mps.mpg.de/phd/open-projects`

*See also* http://www.mps.mpg.de/phd/applynow

# *Announcements*

## ExoMol database update

The ExoMol project provides extensive molecule line lists (lists of transition frequencies and associated Einstein $A$ coefficients) for use in studies of exoplanet and other hot atmospheres. The ExoMol database, which is hosted at www.exomol.com, has undergone a major upgrade providing both more comprehensive sets of data, i.e. more molecules, and a richer set of data, i.e. more features. The newly implemented data structure augments the provision of energy levels (and hence transition frequencies) and Einstein $A$ coefficients with other key properties, including pressure-broadening parameters, lifetimes of individual states, temperature-dependent cooling functions, Landé $g$-factors, partition functions, cross sections, $k$-coefficients and transition dipoles with phase relations. Particular attention has been paid to the treatment of pressure broadening parameters. The new data structure includes a definition file which provides the necessary information for utilities accessing ExoMol through its application programming interface (API). This new upgrade is fully documented in a recently published article (Tennyson et al. 2016, J. Molec. Spectrosc., 327, 73 or ArXiv/1603.05890). We welcome comments, feedback and suggestions for improvements and new molecules.

*See also* www.exomol.com

# IAUS 331: "SN 1987A, 30 years later – Cosmic Rays and Nuclei from Supernovæ and their aftermaths" (20–24 February 2017, St. Gilles, La Réunion Island, France)

Dear colleague,

The Symposium from the International Astronomical Union IAUS 331: "SN 1987A, 30 years later – Cosmic Rays and Nuclei from Supernovæ and their aftermaths"

Where? Saint-Gilles-Les-Bains, La Réunion Island (Indian Ocean), France

When? February 20–24, 2017

It aims at making the link between the stellar progenitors and the multi-wavelength/multi-messenger manifestation of core-collapse (cc-)Supernovæ (SNe) and their remnants (SNRs) in terms of extreme sources of high-energy particles and nuclei, at the occasion of the $30^{\text{th}}$ anniversary of the unique event SN 1987A. Through an interdisciplinary approach, the Symposium will span a broad spectrum of interconnected, topics within this rapidly evolving research field of cc-SNe and SNRs.

We invite contributions on the following topics:

- Latest evolutionary stages of massive stars as cc-SN progenitors
- cc-SNe as stellar explosive outcomes
- cc-SN explosion mechanisms
- cc-SN remnants and impacts
- Particle acceleration & Origin of cosmic rays
- SN 1987A, 30 years later
- Non-thermal multi-wavelength/multi-messenger data on SNe and SNRs

Confirmed invited speakers are:

- Poonam Chandra (NCRA–TIFR, India)
- You-Hua Chu (ASIAA, Taiwan)
- Anne Decourchelle (CEA/SAp, France)
- Fiorenza Donato (Univ. Torino, Italy)
- Clæs Fransson (OKC, Sweden)
- Christopher L. Fryer (LANL, USA)
- Brian Grefenstette (SRL, Caltech, USA)
- Alexander Heger (MoCA, Monash Univ., Australia)
- Raphaël Hirschi (Keele Univ., UK)
- Robert P. Kirshner (CfA Harvard, USA)
- Kei Kotake (Fukuoka Univ., Japan)
- Shiu-Hang Lee (ISAS/JAXA, Japan)

- Julie McEnery (NASA/GSFC, USA)
- Giovanni Morlino (INFN/Gran Sasso Science Institute, Italy)
- Salvatore Orlando (INAF/OAPa, Italy)
- Georg Raffelt (MPP, Germany)
- Irene Tamborra (NBIA, Denmark)
- Stefano Valenti (UC Davis, USA)
- Giovanna Zanardo (ICRAR, Australia)

Request for IAU Financial Support is open until October, 20$^{th}$ 2016. IAU grants are meant to support qualified scientists to whom only limited means of support are available, e.g., colleagues from economically less privileged countries and young scientists. Deadline for Early registration (250 EUR) and abstract submission is set to November, 10$^{th}$ 2016. Late registration (300 EUR) is possible until December, 20$^{th}$ 2016.

For more information, please visit the website at the following (new!) URL: https://iaus331.lupm.in2p3.fr

Interested in attending the meeting? Just let us know by using the dedicated Contact form on the above website. If you have any question concerning the Symposium, please contact us at iaus331@lupm.univ-montp2.fr.

Looking forward to welcoming you in La Réunion Island!

The IAUS 331 SOC: Elena Amato, Aya Bamba, Andrei Bykov (co-Chair), Roger Chevalier, Roland Diehl, Gloria Dubner (co-Chair), Fiona Harrison, Hans-Thomas Janka, Marianne Lemoine-Goumard, Alexandre Marcowith (co-Chair), Georges Meynet, Alak Ray (co-Chair), Matthieu Renaud, Samar Safi-Harb, Stephen Smartt, and Patricia Whitelock

*See also* https://iaus331.lupm.in2p3.fr