THE AGB NEWSLETTER

An electronic publication dedicated to stellar evolution on the asymptotic giant branch and beyond

No. 72 — 01 July 2000

Editors: Thierry Forveille and Claudine Kahane (agbnews@obs.ujf-grenoble.fr)
ISSN 1290-3930

Abstract of recently accepted papers

Re-processing of the Hipparcos Intermediate Astrometric Data and Transit Data of spectroscopic binaries. I. Ba, CH and Tc-poor S stars

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The Intermediate Astrometric Data (IAD) and Transit Data (TD) made available by ESA after the Hipparcos mission make it possible to re-process the observations of any Hipparcos entry. This paper illustrates how TD and IAD may be used in conjunction with the orbital parameters of spectroscopic binaries to improve the astrometric parameters of binaries considered as single stars in the original reduction process. That approach has been applied to 81 dwarf barium stars, strong and mild barium stars, CH stars, and Tc-poor S stars for which spectroscopic orbits became available recently. Among these 81 systems, 23 yield reliable astrometric orbits, thus making it possible to evaluate on real data the impact of an unrecognized orbital motion on the proper motion (Wielen, 1997, A&A 325, 367). Comparison of the proper motion from the Hipparcos catalogue with that re-derived in the present work indicates that the former are indeed far off the present value for binaries with periods in the range 3 to about 8 years. Hipparcos parallaxes of unrecognized spectroscopic binaries turn out to be reliable, except for systems with periods close to 1 year, as expected. Finally, we show that, even when a complete orbital revolution was observed by Hipparcos, the inclination is unfortunately seldom precise.

Accepted by A&A Suppl.
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or via WWW on http://www-astro.ulb.ac.be/Html/ps.html#IAD1

ISO-LWS observations of rotational CO lines from C-Rich objects : AFGL 2688, AFGL 618 and NGC 7027

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We present ISO-LWS full scan observations of CO rotational emission lines (J=14-13 up to J=37-36) from two C-rich post-AGB objects, AFGL 2688; AFGL 618, and one C-rich PN, NGC 7027. The presence of high rotational lines cannot be explained by a spherical, constant velocity wind during the previous AGB phase, but indicates a layer of warm, dense gas with a substantial beam filling factor ($\Omega > 10^{-10}$sr). By simple optically thin calculations, we estimate the total mass of gas cooled through CO rotational lines to be typically ~ 0.1 $M_{\odot}$.

We also consider the physical processes responsible for heating and cooling the warm gas in these objects. Energy sources for the gas could include FUV photons, resulting in a PhotoDissociation Region (PDR), as well as shocks driven by the interacting winds during this evolutionary phase. We have calculated detailed models for the heating and cooling in C-rich PDRs and shocks in order to explain the CO spectra observed. In both models, the gas is cooled radiatively by molecular rotational lines as well as by atomic fine structure lines. Both models can produce warm gas of >500 K at a density of $10^6 - 10^7$ cm^{-3}.

We conclude that the source of heating for the young PN, NGC 7027, is FUV photons from the central star. For the least evolved post-AGB star, AFGL 2688, the effective temperature is too cool to produce many FUV photons to heat the gas. However, there is evidence of a fast wind developing and hence the most likely heating mechanism for the envelope is shocks. For AFGL 618, the central star is hot enough to provide copious amounts of FUV photons but fast outflows have also been observed and both processes may be operational. However, in view of [O I] 63μm high resolution observations, the heating mechanism is more likely to be a PDR.

Accepted by A&A

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Three Dimensional Magneto-Hydrodynamical Modeling of Planetary Nebuale II: The Formation of Bipolar and Elliptical Nebulae with Point-Symmetric Structures and Collimated Outflows

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This work presents three dimensional, magneto-hydrodynamical simulations of the formation and early evolution of a subgroup of planetary nebulae that exhibit a variety of point-symmetric structures. For bipolar nebulae, the formation of point-symmetric nebular shapes along the inner borders of their opposing lobes and/or collimated outflows or jets internal or external to their cavities, is reproduced by considering a steady misalignment of the magnetic collimation axis with respect to the symmetry axis of the bipolar wind outflow, defined perpendicular to the equatorial density enhancement. Elliptical planetary nebulae with ansae displaced from the symmetry

axis in point-symmetric fashion are reproduced through the same process by reducing the equatorial density enhancement. This mechanism represents an alternative explanation to some cases where morphological appearances give the impression of the action of a symmetric, rotating or precessing jet from the central source. The computational survey reveals that jet formation is detected only for dense enough winds with mass loss rates $\gtrsim 10^{-7}$ solar mass/yr. For lower mass loss rates the jets tend to vanish leaving behind only ansae-like structures at the tips of the lobes, as observed in some cases. The results are rather independent of the wind terminal velocity, since magnetized bubbles behave adiabatically for low wind velocities ($\simeq 100 km/s$), which in the absence of a magnetic field would behave as momentum driven.

Accepted by ApJ *Preprints can be obtained by anonymous ftp to* pegasus.astroscu.unam.mx 132.248.1.8 pub/temporal/GGS

Dredge-up Effects in Galactic and Magellanic Planetary Nebulae

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Chemical abundances are reported for 23 planetary nebulae in the Small Magellanic Cloud. Average abundances agree with values found for HII regions, suggesting that progenitors of most of these objects have been formed in the last 1-2 Gyr. The N/O vs O/H anticorrelation is confirmed for Magellanic and galactic planetaries, and a more robust result is obtained if objects of similar ages (or masses) are grouped together. For a given class, such a negative correlation suggests that the surface enrichment due to dredge-up episodes is more efficient at lower metallicities, in agreement with recent computations.

Accepted by A&A Suppl. *Preprints can be obtained by contacting* roberto@iagusp.usp.br

CO_2 emission in EP Aqr : probing the extended atmosphere

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We present an analysis of the ISO/SWS full resolution scan between 12.5 and 16.5 μm of the O-rich AGB star EP Aqr, exhibiting a number of strong CO_2 emission bands. We have developed a simple LTE model to calculate theoretical CO_2 spectra assuming a single-layer slab geometry and compared the SWS observations to this model in order to infer the physical properties of the extended atmosphere. The single layer slab model is able to reproduce the individual band profiles quite well with optically thick bands (column densities typically $10^{18.5}$ cm^{-2}). The derived excitation temperatures for the different bands are in the range $T \sim 350-700$ K in a region which extends from $\sim 4-9 R_*$. The fundamental CO_2 bending mode at 14.98 μm furthermore shows evidence for an optically thin component arising from a much cooler ($T \sim 100$ K) and more extended ($R_{\rm em} \sim 400 R_*$) layer. The strong spectral signature of $^{13}CO_2$ in the spectrum allows an (uncertain) determination of the $^{12}C/^{13}C \sim 10$. The parameters derived for the CO_2 bands allow us to estimate the local temperature and density structure of the extended atmosphere. We find that the derived local gas temperatures are somewhat lower than predicted by hydrodynamical model calculations whereas the local gas densities are in good agreement with these models when using CO_2 abundances derived from chemical network calculations. The CO_2 layer extends from close to the stellar photosphere to the inner part of the dust forming region which makes it a unique new probe of the whole extended atmosphere and the region where dust formation takes place.

Accepted by A&A *Preprints can be obtained by contacting* cami@astro.rug.nl

The $^{12}C/^{13}C$-ratio in cool carbon stars

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We present observations of circumstellar millimetre-wave ^{13}CO line emission towards a sample of 20 cool carbon stars. Using a detailed radiative transfer model we estimate the circumstellar $^{12}CO/^{13}CO$-ratios, which we believe accurately measure the important stellar $^{12}C/^{13}C$-ratios. For those optically bright carbon stars where it is possible, our derived $^{12}C/^{13}C$-ratios are compared with the photospheric results, obtained with different methods. Our estimates agree well with those of Lambert et al. (1986).

It is shown that a straightforward determination of the $^{12}CO/^{13}CO$-ratio from observed line intensity ratios is often hampered by optical depth effects, and that a detailed radiative transfer analysis is needed in order to determine reliable isotope ratios.

Accepted by A&A

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VLBA observations of SiO masers: arguments in favor of radiative pumping mechanisms

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We have performed VLBA observations of the SiO v=1 and v=2 J=1–0 masers in two AGB stars, TX Cam and IRC +10011. We confirm the ring-like spatial distribution, previously found in several AGB objects, as well as the tangential polarization pattern, already reported for TX Cam. Both properties, that seem to be systematic in this kind of objects, are characteristic of radiatively pumped SiO masers. On the contrary, we do not confirm the previous report on the spatial coincidence between the J=1–0 v=1 and 2 masers, a result that would have argued in favor of collisional pumping. We find that both lines sometimes arise from nearby spots, typically separated by 1–2 mas, but are rarely coincident. The discrepancy with previous results is explained by the very high spatial resolution of our observations, $\sim$ 0.5 mas, an order of magnitude better than in the relevant previously published experiment.

Accepted by Astronomy and Astrophysics

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The Henize sample of S stars: III. Uncovering the binary intruders

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The properties of S stars are investigated thanks to a large observing program devoted to the well-defined Henize sample (205 S stars south of $\delta = -25°$ and brighter than $R = 10.5$, covering all galactic latitudes), in order to derive the respective properties of the intrinsic S stars (genuine thermally-pulsing AGB stars) and of the extrinsic S stars (post mass-transfer binaries).

The stellar sample is first cleaned from a few stars misclassified as S thanks to UBV Geneva photometry and low-resolution spectroscopy. These low-resolution spectra also allow to successfully distinguish subclasses within

the S star family. Dedicated Geneva photometry and high-resolution spectroscopy have led to the discovery of two symbiotic S stars.

The more stringent difference between extrinsic and intrinsic stars is their technetium content, but several other observational parameters are shown to be efficient to some extent in segregating intrinsic S stars from their extrinsic masqueraders (UBV, $JHKL$ and IRAS photometry, radial-velocity standard deviation, shape of the CORAVEL cross-correlation dip, combination of band strength indices derived from low-resolution spectra). Multivariate classification has been performed on the Henize data sample in order to guarantee a classification as objective as possible and handling at the same time a large number of parameters. The resulting clusters separate efficiently extrinsic and intrinsic S stars, allowing to derive the respective properties of these two distinct stellar classes. The population difference between intrinsic and extrinsic S stars is for the first time clearly demonstrated, since intrinsic S stars are far more concentrated towards the galactic plane than extrinsic S stars ($z_{\rm int} = 200 \pm 100$ pc and $z_{\rm ext} = 600 \pm 100$ pc), and are therefore believed to belong to a younger, more massive population. The frequency of extrinsic and intrinsic S stars in the magnitude-limited Henize sample amounts to 33% and 67%, respectively. In a volume-limited sample, this proportion is subject to large uncertainties mainly because of uncertain luminosities. There are probably as many as 40% extrinsic stars among S stars in a volume-limited sample.

A&A, in press

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The Henize sample of S stars: II. Data

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This paper presents data collected on the Henize sample of 205 S stars: (i) CORAVEL radial-velocity data; (ii) photometric data in the UBV bands of the Geneva photometric system; (iii) photometric data in the $JHKL$ bands of the SAAO photometric system; (iv) IRAS fluxes; (v) low-resolution spectra of 158 S stars. Close visual companions have been found for Hen 47, 94, 105 and 155. Spectroscopic orbital elements are provided for Hen 2, 108, 121, 137 and 147. The analysis of these data is presented in a companion paper.

A&AS, in press

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Aluminum 26 production in asymptotic giant branch stars

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[1] Geneva Observatory, CH-1290 Sauverny, Switzerland The production of ^{26}Al in asymptotic giant branch (AGB) stars is studied based on evolutionary stellar models of different masses ($1.5 \leq M/\,{\rm M}_\odot \leq 6$) and metallicities ($0.004 \leq Z \leq 0.02$). It is confirmed that ^{26}Al is efficiently produced by hydrogen burning, but destruction of

that nuclei by n-capture reactions during the interpulse and pulse phases becomes increasingly more efficient as the star evolves on the AGB.

The amount of ^{26}Al available in the intershell region follows, at a given metallicity, a very well defined pattern as a function of the H-burning shell temperature T_H. Two zones must be distinguished. The first one comprises those He-rich layers containing H-burning ashes which escape pulse injection. The amount of ^{26}Al in that zone ($1-2\times10^{-7}\,M_\odot$ at the first pulse in $1.5-3\,M_\odot$ Z=0.02 stars) steadily decreases with pulse number. Its contribution to the surface ^{26}Al enhancement can only be important during the first pulses if dredge–up occurs at that stage. The second zone consists of the C–rich material emerging from the pulses. The amount of ^{26}Al available in that zone is higher than that in the first zone ($3-4\times10^{-7}\,M_\odot$ at the first pulse in $1.5-3\,M_\odot$ Z=0.02 stars), and keeps constant during about the first dozen pulses before decreasing when $T_H \gtrsim 55\times10^6$ K. This zone is thus an important potential reservoir for surface ^{26}Al enrichment.

Using third dredge–up (3DUP) efficiencies from model calculations, the surface ^{26}Al abundance is predicted to reach $1-2\times10^{-7}$ mass fractions in our low-mass solar metallicity stars, with an uncertainty factor of about three. It decreases with increasing stellar mass, being about three times lower in a $4\,M_\odot$ than in $2-3\,M_\odot$ stars. In massive AGB stars, however, hot bottom burning enables to easily reach surface ^{26}Al mass fractions above 10^{-6}.

The ^{26}Al/^{27}Al ratios measured in meteoritic SiC and oxide grains are discussed, as well as that possibly measured in the nearby C-star IRC+10216. We also adress the contribution of AGB stars to the 2 – 3 $M_\odot$ present day mass of ^{26}Al detected in the Galaxy.

Finally, we discuss the possibility of directly detecting an AGB star or a planetary nebula as a single source at 1.8 MeV with the future INTEGRAL satellite.

Accepted by A&A.

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A comparison of light and velocity variations in Semiregular variables

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NIR velocity variations are compared with simultaneous visual light curves for a sample of late-type semiregular variables (SRV). Precise radial velocity measurements are also presented for the SRV V450 Aql. Our aim is to investigate the nature of the irregular light changes found in these variables.

Light and velocity variations are correlated in all stars of our sample. Based on these results we discuss several possibilities to explain the observed behavior. We find that pulsation is responsible for large amplitude variations. In a recent paper Lebzelter (1999) invoked large convective cells to understand observed velocity variations. This possibility is discussed with respect to the observed correlation between light and velocity changes. In the light of these results we investigate the origin of the semiregular variations.

Accepted by Astronomy & Astrophysics

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Abstract of PhD theses

WINDS FROM RED GIANT STARS
Observations and Modelling of Molecular Line Emission

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Thesis work conducted at: Stockholm Observatory, SE-13336 Saltsjöbaden, Sweden

Ph.D dissertation directed by: Professor Hans Olofsson

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Red giant stars are key objects in many astronomical fields of research. However, they are complicated objects and many physical and chemical processes combine to determine their properties. This makes it difficult to interpret the observations made towards these important stars, and to use them in a quantitative way when probing stellar evolution or galactic structure. A key process for their final evolution is mass loss from the surface, and this also has implications for the nucleosynthesis and the chemical evolution of galaxies. The mass loss leads to the formation of extended circumstellar envelopes of gas and dust particles, and their emission may be used to determine the mass loss characteristics.

We have performed extensive modelling of molecular line emission from the circumstellar envelopes using a detailed radiative transfer analysis. In particular, we present results on carbon monoxide radio line emission from a large sample of optically bright carbon stars. Assuming spherically symmetric envelopes created by a continuous, smooth expanding, mass loss, we are able to reproduce the observational results for about 90% of the sample stars. The derived mass loss rates span almost four orders of magnitude from roughly 5×10^{-9} up to 2×10^{-5} solar masses per year. The physical conditions prevailing in the circumstellar envelopes vary considerably over such a large range of mass loss rates, posing a challenge to the model. A comparison between the stellar and circumstellar properties is also provided. The majority of the remaining stars have known detached circumstellar envelopes, suggesting episodic mass loss.

Carbon stars are probably important in returning processed gas to the interstellar medium. We estimate that carbon stars of the type considered here annually return on the order of 0.05 solar masses of gas to the Galaxy, but more extreme carbon stars may contribute an order of magnitude more. However, as for the total carbon budget of the Galaxy, carbon stars appear to be of only minor importance.

We present estimates of the $^{12}C/^{13}C$-ratio towards a number of carbon stars. This carbon isotope ratio is an important probe of stellar evolution and, if known accurately, should increase our understanding of the processes that lead to the formation of carbon stars.

With the Infrared Satellite Observatory a new window for observing late-type stars was opened up, and this allowed studies of gas much closer to the star than was previously possible using, mainly, ground-based radio telescopes. By combining infrared and radio observations of carbon monoxide rotational lines we have been able to probe the circumstellar envelope characteristics over a large radial range. This provides a form of archaeology, giving a time resolved mass loss history of the object under study. In a similar way we have analysed stellar light scattered in circumstellar rotational-vibrational lines of carbon monoxide.

Finally, we have also performed interferometric observations of the circumstellar line emission from hydrogen cyanide and cyanide, molecules with more complex spectra. Using a detailed treatment of the more complicated radiative transfer in these cases we are able to strengthen the observational constraints put on models describing the circumstellar chemistry.

Announcement

Networking Lunch for Women Astronomers

The Royal Astronomical Society's Committee for Women in Astronomy and Geophysics intend to organise an informal lunchtime meeting on Tuesday 8th August. The aim of this meeting is to provide an informal forum for discussion of the various issues which particularly affect women astronomers.

We hope to invite two or three women astronomers to say a few words on their own experiences to provide a focus for general discussion and we will write up a report of the meeting for Astronomy and Geophysics magazine.

We will provide a light buffet lunch although as our budget is limited, we encourage anyone who has already pre-booked a packed lunch to take it along. The venue is yet to be decided but will be on the main Manchester University site. The choice of venue will depend on the expected number of participants.

Any GA24 participants (including men and non-astronomer partners) who would be interested in attending this meeting are invited to contact the organiser:

Dr. Myfanwy Bryce
Jodrell Bank Observatory

Jobs

One year postdoctoral fellowship in stellar astrophysics at GRAAL, Montpellier University, France

Application are invited for a one year postdoctoral position in stellar physics and spectroscopy. Only candidates from the following countries will be considered: Australia, Brazil, Canada, China, Corea, India, Israel, Japan, Mexico, New-Zealand, Switzerland, Turkey and USA.

Research Activities at GRAAL include: model atmospheres for late-type stars, stellar evolution, chemical analysis of metal-poor stars, cool stars, AGB and post-AGB stars (with a special attention to Li), circumstellar envelopes, winds. Further information may be obtained on: http://www.isteem.univ-montp2.fr/GRAAL/index.html

The monthly salary will be 12000FF, starting October 1, 2000.

Applications including a curriculum and a 1 or 2 pages research project should be sent before August 15, 2000 to:

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or by email to plez@graal.univ-montp2.fr who may be contacted for more information.