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From the editors

Please note that the internet address of the computer on which we prepare the AGB newsletter has changed, from gag.observ-gr.fr to obs.ujf-grenoble.fr.

Abstracts of recently accepted papers

H_2O maser emission from irregular variables

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We have performed a search for the 22 GHz water maser line among 72 optically identified irregular and semiregular red variables. New detections were made of five stars, while only four of nine objects previously known as maser sources were redetected. The probability for the detection of H_2O maser emission increases with V light amplitude, and with $H-K$ and $K-[12]$ colours just as in regular Mira and semiregular variables of SRa– and SRb–types. The detection rate of water masers is about 25% for nearby Lb objects (D <400 pc) in the sample, comparable to that observed in the SRa and SRb stars. No masers were detected in objects with mass loss rates $\leq 4\,10^{-8} M_{\odot}\mathrm{yr}^{-1}$. Maser luminosities are $10^{41} - 10^{43}$ photons s^{-1} similar to that of the bluest Miras and typical SRa and SRb stars showing water maser emission. A comparison of our data on irregular stars with those previously obtained on SRa and SRb variables suggests that most radio and infrared properties are indistinguishable among both classes of objects.

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A new, evolved bipolar planetary nebula

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Optical imaging and spectroscopy reveal that the ionised region No.252 in the list of Marsalkowa (1974), whose photograph is presented in the "Atlas of Galactic Nebulae" by Neckel & Vehrenberg (1990), is actually a planetary nebula. According to Acker et al. (1992), the object should therefore be named as PN G321.6+02.2. The nebula has the following properties: it is located at 2.0±0.5 kpc from the Sun, has a bipolar morphology, a giant size (∼4 pc!), low densities, a hot (unobserved) central star (T>130000 K), and extreme He and N overabundances (He/H=0.147±0.029, log(N/O)=$0.47^{+0.20}_{-0.38}$). The nebula is likely to be in a very evolved evolutionary stage.

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Preprints can be obtained by contacting rcorradi@iac.es, *or via WWW on* http://www.iac.es/proyect/PNgroup/root/iacpn.html, *or via anonymous ftp to iac.es* on pub/romano/mrsl252.ps.gz

HIPPARCOS Parallaxes of Mira Variables

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HIPPARCOS trigonometrical parallaxes are given for 16 pre-selected Mira variables. Linear diameters are derived for 8 oxygen-rich Miras with known angular diameters. Comparison with pulsation theory shows that two of them (both with periods over 400 day) are fundamental pulsators, the others (all with periods less than 400 day) pulsate in an overtone. The Mira PL relations in M_K and M_{bol} are calibrated for oxygen-rich overtone pulsators adopting slopes for these relations from LMC data. A mean LMC distance modulus of 18.54 is derived; this is very close to that of 18.57 derived from the Cepheids. The uncertainty in the value derived from the Miras is estimated to be less than 0.2 mag. The absolute magnitude of the only carbon-rich Mira in the sample, R Lep (period of 427 day), indicates that it is a fundamental pulsator. Other stars discussed individually are: the symbiotic Mira, R Aqr; the double-period Mira, R Cen; and, two Miras with decreasing periods, R Aql and R Hya.

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Mass Loss Variations Among Carbon-Rich AGB Variables

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Near-infrared light curves are presented for eleven large amplitude carbon variables, covering time periods of nine to twenty-two years. The light curves differ greatly among the various stars, although there is some degree of similarity among those with similar mass-loss characteristics. Three Miras with moderately thick dust shells, R For, R Lep and R Vol, exhibit large amplitude, up to $\Delta J \sim 2$ mag, erratic changes on top of their normal pulsational variations. The similarity between their light curves and those of R Coronae Borealis stars is noted. Evidence is presented which suggests that carbon-rich dust ejection occurs in a preferred direction, possibly from the equator. In the case of R Lep at least, the preferred direction coincides with the line of sight. Periodic variations of the dust shell, which have previously been suggested for R For, are not confirmed. Three Miras with very thin dust shells, V Cru, TT Cen and RV Cen, show rather little in the way of long-term trends. One of two thick-shelled sources, IZ Peg (CRL 3099), has a pulsation amplitude which has been gradually increasing over the last 16 years. The three semi-regular variables, R Scl, GM CMa and *IRAS* 04067–0922, all show evidence of detached shells. Two of them also have double periods: GM CMa at twice the dominant pulsation period and R Scl at approximately five times the dominant pulsation period.

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A 200 km s^{-1} Molecular Wind in the Peculiar Carbon Star V Hya

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A molecular wind with an outflow speed in excess of 200 km s^{-1} has been found in the AGB carbon star V Hya. Observations of several molecular lines show that the circumstellar envelope is expanding at 15 km s^{-1} and is flattened and inclined to the line of sight. The fast wind appears to be expanding from the poles of the envelope, with the expansion speed increasing with distance from the star. V Hya may be in the very earliest stage of evolution beyond the AGB.

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Mid- and far-infrared properties of dynamical models of carbon-rich long-period variables

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We have calculated spectral energy distributions and synthetic IRAS colours of carbon-rich long-period variables. On top of dynamical models for the stellar atmosphere and circumstellar envelope which consistently treat the time-dependent hydrodynamics, the formation of amorphous carbon grains and grey radiative transfer, frequency-dependent radiative transfer calculations have been carried out in the range between 1 μm and 290 μm. Calculating the IRAS colours we find that the models lie in regions I (stars without circumstellar shells) and VII (variable stars with carbon-rich circumstellar shells) of the IRAS two colour diagram in accordance with observational results for carbon stars. They form an almost linear sequence (near the black body line) reflecting the different mass loss rates. We compare our results to empirical formulae which link the mass loss rate to the observed flux at 60 μm. Furthermore, we have also investigated qualitatively the effects of dust with α-SiC grains and of detached shells. The SiC-contribution causes mainly a blue-shift of about 0.2 mag in the [12]$-$[25] colour. Adding a detached shell results in higher [25]$-$[60] values partly shifting the models into region VIa (non-variable stars with relatively cold dust at large distances) of the IRAS two colour diagram as expected from observations.

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BD−21°3873: Another yellow-symbiotic barium star

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An abundance analysis of the yellow symbiotic system BD−21°3873 reveals it to be a metal-poor K-giant ([Fe/H] = −1.3) which is enriched in the heavy s-process elements. In that respect, this star appears to be a twin of AG Dra, another yellow symbiotic system analyzed in a previous paper (Smith et al., 1996, A&A 315, 179). The heavy-element abundance distributions of AG Dra and BD−21°3873 are almost identical, and are best reproduced by a s-process with a neutron exposure parameter of 1.2 – 1.3 mb^{-1} and a neutron density $\log N_{\rm n} = 8.3$ (as derived from the Rb/Zr ratio). These two systems thus link the symbiotic stars to the binary barium and CH stars which are also s-process enriched. These binary systems, which exhibit overabundances of the heavy elements, owe their abundance peculiarities to mass transfer from thermally-pulsing asymptotic giant branch stars, which have since evolved to become white-dwarf companions of the cool stars we now view as the chemically-peculiar primaries.

The spectroscopic orbits of BD−21°3873 (derived from CORAVEL measurements) and AG Dra are similar to those of barium and CH stars. With an orbital period of 281.6 d, BD−21°3873 is one of the closest systems in these families, and its light curve indeed suggests that variations due to reflection and ellipticity effects are present. The amplitude of the ellipsoidal variations indicates that the giant must be close to filling its Roche lobe. However, no acceptable solution simultaneously satisfies the constraints from the light curve, the orbital elements and the evolutionary tracks in the framework of the standard Roche lobe geometry. We suggest that this discrepancy may be resolved by taking into account the deformation of the Roche lobe caused by the force driving the large mass loss of the giant.

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Hydrodynamical models and synthetic spectra of circumstellar dust shells around AGB stars. I. Stationary solutions

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We present a sample of hydrodynamical steady state models of circumstellar gas/dust shells around late type giants together with computed spectral energy distributions (SEDs). In these models, the stellar wind is driven by radiation pressure on dust grains and subsequent momentum transfer to the gas molecules via collisions. Given the fundamental stellar parameters (M_*, L_*, T_{eff}), the mass loss rate ($\dot{M}$), and the dust properties, a self-consistent physical modelof the circumstellar gas/dust shell is obtained from the numerical solution of the coupled equations of hydrodynamics and radiative transfer. The computed outflow velocities and infrared fluxes of the circumstellar envelopes can be compared directly with the observed properties of stars on asymptotic giant branch.

Plotting the positions of our steady state models in different IRAS two-color-diagrams, we confirm that, for fixed dust properties, all models fall on a simple color-color relation with $\dot{M}$ (or optical depth) as the only parameter. Surprisingly, we find a good agreement between the synthetic spectra resulting from the self-consistent hydrodynamical approach and those obtained from much simpler models based on a constant outflow velocity and ignoring drift of dust relative to the gas.

Our models are compared with the results of similar calculations by Netzer & Elitzur (1993). We find significant differences which are probably the result of some unrealistic approximations in the treatment of radiative transfer underlying the model calculations of Netzer & Elitzur. Moreover, our results demonstrate that, in general, gas pressure cannot be neglected for winds with relatively low expansion velocities ($u_e < 30$ km/s). For given stellar parameters and dust properties, the theoretical minimum (maximum) mass loss rate decreases (increases) significantly when gas pressure is taken into account.

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The chemical evolution of planetary nebulae

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We report millimeter line observations of CO, ^{13}CO, SiO, SiC_2, CN, HCN, HNC, HCO^+, CS, and HC_3N to study the chemistry in planetary nebulae (PNe) with massive envelopes of molecular gas. The sample observed consists of representative objects at different stages of development in order to investigate evolutionary effects: the proto-PNe CRL 2688 and CRL 618, the young PN NGC 7027, and the evolved PNe NGC 6720 (the Ring), M4-9, NGC 6781, and NGC 7293 (the Helix).

The observations confirm that the chemical composition of the molecular gas in PNe is radically different from that in interstellar clouds and the circumstellar envelopes of Asymptotic Giant Branch (AGB) stars. There are also clear trends in the chemical evolution of the envelopes. As a star evolves beyond the AGB, through the proto-PN and PN phases, the abundances of SiO, SiC_2, CS, and HC_3N decrease, and they are not detected in the PNe, while the abundances of CN, HNC, and HCO^+ increase dramatically. Once a PN has formed, the observed abundances in the molecular clumps of the envelope remain relatively constant, although HNC is anomalously underabundant in NGC 7027. In the evolved PNe, CN is about an order of magnitude more abundant than HCN, HNC, and HCO^+, and the average abundance ratios are CN/HCN = 9, HNC/HCN = 0.5, and HCO^+/HCN = 0.5. These ratios are, respectively, one, two, and three orders of magnitude higher than in the prototypical AGB envelope IRC+10216. The $^{12}C/^{13}C$ ratios are $\approx$10–25, within the large range found in AGB envelopes. The chemical evolution of the envelopes likely occurs through the development of photon-dominated regions produced by the ultraviolet radiation field of the central star.

The observations also provide important information on the physical conditions in the molecular gas. Multi-line observations of CN, CO, and HCO^+ show that the clumps which form the envelopes of the evolved PNe maintain remarkably high gas densities ($\sim$ few $\times 10^5$ cm^{-3}) and low temperatures ($\sim$25 K). These values are consistent with the idea that the clumps are in rough pressure equilibrium with the more diffuse, ionized gas and can last for a significant part of the nebular lifetime, providing the environment needed for the survival of the molecules. Thus the clumping of the gas in these PNe is an essential aspect of both their physical and chemical evolution.

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Time dependent ionization calculations of gaseous nebulae

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We developed a new computer code which is able to treat the time dependent photo- and collisional ionization of gaseous nebulae together with the consistent energy balance for arbitrary numbers of elements, ions and line transitions. The intention of this paper is to describe the basic numerical methods and a few test calculations as being parts of full spherically symmetric radiation-gasdynamic computations in the limit of a non-moving gas ($v(r) = 0$). Exemplarily we discuss the evolution of ionization fronts around a suddenly switched-on/switched-off central star with $T_{eff} = 50\,000\,\mathrm{K}$ and $L_* = 6000\,\mathrm{Lsun}$ Evidence is presented that the photon velocities must artificially be limited in time dependent astrophysical calculations when the equation of radiative transfer is not explicitely treated in a time dependent way. Furthermore, computations with different spatial resolutions demonstrate that a careful choice of the grid resolution in ionization calculations is essential for the interpretation of observed line intensities.

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A revised period-luminosity relation for carbon Miras

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We have obtained a $150 \times 150''$ map of the 1.3 mm emission around the carbon star CW Leo. Emission is detected at the 3σ level out to a distance of $50''$ from the central star. From model calculations we find that the dust density distribution is described by an approximate r^{-2} law superposed on which are possible density enhancements at about 5 and $20''$ distance from the star. This could imply phases of enhanced mass loss lasting up to several hundred years duration over the last few 1000 years. The major uncertainty in a quantitative analysis is in the contribution of molecular lines. The density enhancement at $5''$ is consistent with a recent phase of increased mass loss as inferred from CO data.

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On a Rapid Lithium Enrichment and Depletion of K Giant Stars

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A model scenario has recently been introduced to explain the presence of very strong Li lines in the spectra of some low mass K giant stars (de la Reza et al. 1996). In this scenario *all* ordinary, Li poor, K giants become Li rich during a short time ($\sim 10^5$ yr) when compared to the red giant phase of $5 \cdot 10^7$ yr. In this "Li period", a large part of the stars are associated with an expanding thin circumstellar shell supposedly triggered by an abrupt internal mixing mechanism resulting in a surface new ^{7}Li enrichment. This letter presents near 40 Li rich K giants known up to now. The distribution of these Li rich giants, along with other 41 observed K giants that have shell, but are not Li rich, in a color-color *IRAS* diagram confirms this scenario, indicating, also as a new result, that a rapid Li depletion takes place on a time scale of between $\sim 10^3$ and 10^5 yr. This model explains the problem of the presence of K giants with far infrared excesses presented by Zuckerman et al. (1995). Other present and future tests of this scenario are briefly discussed.

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Circumstellar gas in the wide binary HD 188037

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We report radio, optical and ultraviolet studies of the wide binary HD 188037 = IRC+20439. We detect the CO (2-1) and (1-0) rotational lines from the circumstellar envelope in this system which consists of a luminous ($\sim$7000 $L_\odot$) mass-losing M-type star and, at a separation of 0".75, a main sequence A-type star. The strong (2-1) line has a very unusual skewed shape with a width at zero intensity of about 30 km s^{-1} which we explain with a model where the gas ejected by the M-type star is preferentially photodissociated on one side of the outflow by ultraviolet light from the A-type companion. We infer that the wind from the M giant expands at 15 km s^{-1} and, for an estimated distance of 300 pc, carries $\sim 3 \times 10^{-7}$ $M_\odot$ yr^{-1}. Our simplified model for CO in a wind being photodissociated by ultraviolet from a companion explains why CO can be detected around Mira yet not around α Sco.

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