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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. We have been told the old address should remain a valid alias for the foreseeable future, but it is certainly safer if you don't wait to switch to the new address.

Abstracts of recently accepted papers

The chemical structure of bipolar planetary nebulae. I. IC 4406

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Long slit spectrophotometry of the bipolar planetary nebula IC 4406, in the range from 360 to 930 nm, has been used to study the chemical structure along its major axis. We find that:
– the He, O, N, Ne, and Ar abundances are constant, within errors, along the major axis of the nebula. Average values for He/H, O/H, N/H, Ne/H, and Ar/H are: 0.126, 5.6×10^{-4}, 2.0×10^{-4}, 1.7×10^{-4} and 3.2×10^{-6}, respectively. The N and He abundances of IC 4406 are quite modest for objects in this morphological class.
– The computed abundances of sulphur indicate an increase of S/H towards the external parts of the nebula, which may likely reflect inaccuracies in the available ionization correction factors.

Within the accuracy of the present data and analysis method, IC 4406 appears therefore to be a *chemically homogeneous* object.

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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/i4406.ps.gz

Stellar sapphires: The properties and origins of presolar Al_2O_3 in meteorites

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Thirty-seven isotopically highly anomalous presolar Al_2O_3 grains and one presolar $MgAl_2O_4$ grain from a separate of the Tieschitz H3.6 ordinary chondrite were identified out of ~15,000 isotopically normal refractory oxide grains by an automatic $^{16}O/^{18}O$ low-mass-resolution ion imaging mapping technique in the ion microprobe. Eight additional presolar Al_2O_3 grains were found by high-mass-resolution ion probe measurements of all three stable O isotopes in individual grains, including several that would have been missed by the ion imaging search. Forty-five of the grains were analyzed for their $^{16}O/^{17}O$ and $^{16}O/^{18}O$ ratios. Twenty-four grains were also analyzed for Al-Mg and 17 of them have large excesses of ^{26}Mg, attributable to the radioactive decay of ^{26}Al. The highly anomalous isotopic composition of the grains is evidence for their presolar, stellar origin.

The 46 oxide grains of this study together with 42 previously identified presolar grains were divided into four groups. These groups most likely comprise grains from distinct types of stellar sources. *Group 1* grains have ^{17}O excesses and moderate ^{18}O depletions, relative to solar, and many of them exhibit ^{26}Mg excesses as well. *Group 2* grains have ^{17}O excesses, large ^{18}O depletions and high inferred $^{26}Al/^{27}Al$ ratios. *Group 3* grains have solar or higher $^{16}O/^{17}O$ and $^{16}O/^{18}O$ ratios. *Group 4* grains have ^{17}O and ^{18}O enrichments. One Al_2O_3 grain of this study, T54, has an $^{16}O/^{17}O$ ratio of 71, lower than any previously observed, and $^{16}O/^{18}O$ much greater than the solar value.

The O-isotopic compositions of Group 1 and Group 3 grains are consistent with an origin in O-rich red giant stars, which have undergone the first dredge-up. The range of O-isotopic ratios of these groups requires multiple stellar sources of different masses and initial isotopic compositions, and is well explained by a combination of galactic chemical evolution and first dredge-up models. The inferred $^{26}Al/^{27}Al$ ratios of many of these grains indicate that they formed in thermally-pulsing asymptotic branch (TP-AGB) stars that had undergone the third dredge-up. Group 2 grains probably formed in low-mass AGB stars as well, and their substantial ^{18}O depletions are the likely result of "extra" mixing (cool-bottom processing). The origin of the ^{18}O enrichments in Group 4 grains is unknown, but might be due to initial compositional differences of the stellar sources or to unusual third dredge-up in low-mass AGB stars. The highly ^{17}O-enriched grain T54 could have formed in an AGB star undergoing hot-bottom burning or in a massive star in the Of-WN phase.

O-rich circumstellar dust seems to be under-represented in meteorites, relative to C-rich. Explanations include the possibility that most O-rich stardust grains are silicates and have been destroyed either in the laboratory or in nature and the possibility that presolar Al_2O_3 has a finer grain size distribution than SiC and graphite.

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The onset of photometric variability in red giant stars

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The onset of variability in red giant stars is studied from the data collected by the 'Long-Term Photometry of Variables' project which operates at ESO (La Silla) since 1982. The differential nature of the observations

combined with a multi-night reduction algorithm enables to study the variability of over 50 red giants with an accuracy of the order of 2 to 3 millimagnitudes on time scales ranging from days to years. All red giants with spectral types late G to early K (i.e. $b-y \sim 0.6-0.8$) are stable at the level $\sigma_y < 6$ millimag (where σ_y is the standard deviation of the Strömgren y magnitude). Red giants with later spectral types are all variable, and it is found that the minimum variability level $\sigma_{y,min}$ increases with increasing $b-y$, thus defining a *minimum-variability boundary*. The new data obtained in this paper reveal that the time scale of the associated variability increases with increasing $b-y$ (and thus amplitude), and that the stability of this time scale improves concomitantly. More precisely, irregular variations on time scales of 5 to 10 days (and $\sigma_y \sim 7$ millimag) characerize red giants with $b-y \sim 1.0$, whereas the variations (with $\sigma_y \sim 100$ millimag) become more regular with periods of the order of 50 d for red giants with $b-y \sim 1.3$. A radial-velocity jitter (of the order of 1.5 km/s r.m.s.) is associated with this photometric variability, and suggests that stellar oscillations may be responsible for the observed variations.

Accepted by A&A *Preprints can be obtained by contacting* jorissen@astro.ulb.ac.be *or via anonymous ftp on* ftp://obsftp.unige.ch/pub/mowlavi, *file* variab.ps.gz

Line emission in stellar envelopes

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We examine the problem of what could be called a 'compact planetary nebula' in studying the radiative equilibrium of a spherical envelope with inner radius comparable or equal to the radius of the illuminating core. The envelope is composed of hydrogen atoms in statistical equilibrium and photoionized by a central radiation of relatively high temperature $T_* > 15\,000$ K. We consistently solve the equations of radiative transfer in spherical geometry for all lines and continua, including the Lyman transitions, together with the equations of statistical equilibrium. Yet we ignore the energy-balance equation and consider the electronic temperature as a given parameter. We show that Balmer and other subordinate lines may appear in emission, even at low temperature, provided that (i) the density is low enough for the radiative terms to partly control the populations of the levels and (ii) the geometrical extension of the HII region is significant. Although the present model is only intended to isolate and illustrate a specific physical mechanism, we suggest that the emission features detected in the spectrum of cool giant or supergiant stars could result from purely radiative processes, at least in some cases.

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Axially Symmetric Superwinds of Proto–Planetary Nebulae with 21 μm Dust Features

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We present narrow band images at selected wavelengths in the 8-13 μm window of four carbon rich, proto–planetary nebulae that have an unusual 21 μm dust feature: *IRAS* 04296+3429, *IRAS* 22272+5435, *IRAS* 07134+1005 and *IRAS* 19500–1709. We observe axially symmetric dust emission structures in *IRAS* 22272+5435 and

IRAS 07134+1005, tentatively in *IRAS* 19500–1709 while *IRAS* 04296+3429 is unresolved with our ∼1 arcsec angular resolution. The well resolved morphology of *IRAS* 07134+1005 shows an elliptical outer shell surrounding two aligned peaks that we interpret as limb brightened peaks of an optically thin, elliptical shell with an equatorial density enhancement. This mid–IR morphology contrasts with that observed in the better studied carbon rich proto–planetary nebulae, AFGL 2688, AFGL915 and AFGL 618, which show bright, unresolved cores, probably created by optically thick inner regions, and bipolar extensions that align with their optical reflection nebulosities. Using an axially symmetric dust code and assuming that the dust is composed of 0.01 μm amorphous carbon grains, we model the dust emission images and the spectral energy distributions of these four proto–planetary nebulae and of the young, carbon rich planetary nebula, *IRAS* 21282+5050, that also has an axially symmetric dust shell and has other similarities with the proto–planetary nebulae that have the 21 micron dust feature. Marginally resolved mid–infrared images constrain the dust shell's inner radius while well resolved mid–infrared images additionally constrain other geometric parameters of the model (e.g., inclination angles and pole to equator mass loss rate ratios). The modelling reveals that the observed axial symmetry in the dust shells of these objects coincides with an enhanced mass loss phase ($\sim 3 \times 10^{-5}$ $M_\odot$ yr^{-1}) during which the equatorial mass loss rate was a factor of 18 to 90 higher than the polar mass loss rate; i.e. an axially symmetric superwind. Our dynamical age estimates indicate that these stars left the asymptotic giant branch approximately 300-1400 years ago, just after the superwind phase. For each object, the size and structure of the dustshell is the same for the sampled wavelengths with the exception of *IRAS* 22272+5435 for which the 11.8 μm emission is larger than either the 8.2 or 9.7 μm emission. *IRAS* 22272+5435's spectrum has a larger dust feature to dust continuum ratio than found in the other objects and hence its 11.8 μm image is probably dominated by the 11.8 μm feature emission that has different optical properties than the underlying continuum.

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High-Resolution X-ray Image of the Hydrogen-Deficient Planetary Nebula Abell 30

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Abell 30 is the brighter of only two planetary nebulae that show extended X-ray emission. Our recent *ROSAT* High Resolution Imager observation of A30 reveals a central source at a 4σ level and emission knots at a 2σ level. These emission features are within the same region as the H-deficient knots and filaments resolved in a previous *HST* WFPC2 [O III] image. The *ROSAT* position of the X-ray peak is offset by $2''.8$ from the *HST* position of the central star of A30. Since the *ROSAT* pointing may be uncertain by up to $10''$, we assume that the X-ray peak is aligned with the central star. The two brighter X-ray emission knots then become aligned with prominent [O III] features in the nebula. Ground-based echelle observations and *HST* WFPC2 images of A30 reveal a bipolar pair of knots and a clumpy expanding disk. The morphology and velocity structure of the bipolar knots and disk show evidence of the stellar wind ablating the knots and clumps. An efficient mixing of the shocked stellar wind and the ablated material is needed to produce the low plasma temperature, 4.5×10^5 K, and the high electron density, $\sim$1000 cm^{-3}, derived from the observed X-ray flux and spectral distribution.

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Non-Uniform Dust Outflow Observed around Infrared Object NML Cygni

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Measurements by the U.C. Berkeley Infrared Spatial Interferometer at 11.15 μm have yielded strong evidence for multiple dust shells and/or significant asymmetric dust emission around NML Cyg. New observations reported also include multiple 8-13 μm spectra taken from 1994-1995 and N band (10.2 μm) photometry from 1980-1992. These and past measurements are analyzed and fitted to a model of the dust distribution around NML Cyg. No spherically symmetric single dust shell model is found consistent with both near- and mid-infrared observations. However, a circularly symmetric maximum entropy reconstruction of the 11 μm brightness distribution suggests a double shell model for the dust distribution. Such a model, consisting of a geometrically thin shell of intermediate optical depth ($\tau_{11\mu m} \sim 1.9$) plus an outer shell ($\tau_{11\mu m} \sim 0.33$), is consistent not only with the 11 μm visibility data, but also with near-infrared speckle measurements, the broadband spectrum, and the 9.7 μm silicate feature. The outer shell, or large scale structure, is revealed only by long-baseline interferometry at 11 μm, being too cold ($\sim$400 K) to contribute in the near-infrared and having no unambiguous spectral signature in the mid-infrared. The optical constants of Ossenkopf, Henning, & Mathis (1992) proved superior to the Draine & Lee (1984) constants in fitting the detailed shape of the silicate feature and broadband spectrum for this object. Recent observations of H_2O maser emission around NML Cyg by Richards, Yates, & Cohen (1996) are consistent with the location of the two dust shells and provide further evidence for the two-shell model.

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Methane in oxygen-rich circumstellar envelopes: a search for CH_3OH and CCH

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We have searched for rotational emission from CH_3OH and CCH molecules in several oxygen-rich circumstellar envelopes known to display HCN emission. We find no evidence for emission from either molecule. When compared with theoretical models, our upper limits on CH_3OH and CCH in IRC+10011, TX Cam, and IK Tau appear to rule out the hypothesis that the unexpected presence of HCN and other carbon-bearing molecules in these outflows is due to a substantial abundance of methane.

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Circumstellar and Interstellar Synthesis of Organic Molecules

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We review the formation and evolution of complex circumstellar and interstellar molecules. A number of promising chemical routes are discussed which may lead to the formation of polycyclic aromatic hydrocarbon molecules, fullerenes, and unsaturated hydrocarbon chains in the outflows from stars. Some of the problems with these chemical schemes are pointed out as well. We also review the role of grains in the formation of complex molecules in interstellar molecular clouds. This starts with the formation of simple molecules in an ice grain mantle. UV photolysis and/or thermal polymerization can convert some of these simple molecules in

more complex polymeric structures. Some of these species may be released to the gas phase, particularly in the warm regions around newly formed stars. Methanol and formaldehyde seem to play an important role in this drive towards molecular complexity and their chemistry is traced in some detail

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Spectroscopic study of the planetary nebulae with Wolf-Rayet nuclei in the Magellanic Clouds

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UV and optical spectrophotometric data of planetary nebulae with WR nuclei in the Magellanic Clouds are presented. Analysis of the nebular characteristics shows that the ionized gas, in all the objects, is extremely C-rich, probably due to contamination with freshly-made C from stellar nucleosynthesis. Very high electron densities are found ($n_e \geq 10^4$ cm^{-3}) which are interpreted as an indication of youth. The central stars are C-rich, with spectral types in the range from WC 4/5 to WC 8.. The spectral type distribution is totally different from that found for galactic planetary nebulae with WR nuclei. Estimates of the stellar visual magnitudes and temperatures are presented. Stellar temperatures over 60 000 K were derived for all the objects, with some cases exceeding 100 000 K. These high temperatures however do not produce high excitation nebulae.

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Deep optical spectroscopy of planetary nebulae

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Shall we leave this millennium with a template spectrum for PNe based on photographic plates taken nearly half a century ago? Is photoionization being demolished by shock waves in PNe? Is icf getting on well with t^2?

Invited talk, IAU Symp 180, Planetary Nebulae, Groningen, Aug 1996 *Preprints can be obtained by contacting* pequignot@obspm.fr, *or via WWW on* http://adress/directory.html *or via anonnymous ftp on* ftp://adress/directory/publication.tar

Obscured AGB stars in the Magellanic Clouds I. IRAS candidates

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We have selected 198 IRAS sources in the Large Magellanic Cloud, and 11 in the Small Magellanic Cloud, which are the best candidates to be mass–loosing AGB stars (or possibly post–AGB stars). We used the catalogues of Schwering & Israel (1990) and Reid et al. (1990). They are based on the IRAS pointed observations and have lower detection limits than the Point Source Catalogue. We also made cross–identifications between IRAS sources and optical catalogues.

Our resulting catalogue is divided in 7 tables. Table 1 lists optically known red supergiants and AGB stars for which we found an IRAS counterpart (7 and 52 stars in the SMC and LMC, respectively). Table 2 lists "obscured" (or "cocoon") AGB stars or late–type supergiants which have been identified as such in previous works through their IRAS counterpart and JHKLM photometry (2 SMC and 34 LMC sources; no optical counterparts). Table 3 lists known planetary nebulae with an IRAS counterpart (4 SMC and 19 LMC PNe). Table 4 lists unidentified IRAS sources that we believe to be good AGB or post–AGB or PNe candidates (11 SMC and 198 LMC sources). Table 5 lists unidentified IRAS sources which could be any type of object (23 SMC and 121 LMC sources). Table 6 lists IRAS sources associated with foreground stars (29 SMC and 135 LMC stars). Table 7 lists ruled out IRAS sources associated with HII regions, hot stars, etc ...

We show that the sample of IRAS AGB stars in the Magellanic Clouds is very incomplete. Only AGB stars more luminous than typically $10^4\,L_\odot$ and with a mass-loss rate larger than typically $5\,10^{-6}\,M_\odot$/yr could be detected by the IRAS satellite. As a consequence, one expects to find very few carbon stars in the IRAS sample. We also expect that most AGB stars with intermediate mass–loss rates have not been discovered yet, neither in optical surveys, nor in the IRAS survey.

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Candidate planetary nebulae near the galactic center

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We have used sensitive VLA observations made at 20 and 6 cm toward a high energy source near the galactic center to study the nature of three relatively bright ($S_{6cm} > 5$ mJy) unidentified radio sources in the field. All three sources have flat spectral indices and are most probably optically-thin free-free emitters. On the basis of their flux densities, sizes, masses, and morphologies, we tentatively identify two of these sources (G359.023−0.044, G359.139−0.087) as planetary nebulae and the third one (G359.164−0.161) as a compact H II region.

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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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