
THE AGB NEWSLETTER

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

No. 83 — October 2001

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

Abstract of recently accepted papers

R Aquarii: Evidence for Differential Rotation of the SiO Maser Shell

J.M. Hollis^{1,2}, D.A. Boboltz³, J. A. Pedelty⁴, S. M. White², and J. R. Forster⁵

¹ Earth and Space Data Computing Division, Code 930, NASA Goddard Space Flight Center, Greenbelt, MD 20771

² Department of Astronomy, University of Maryland, College Park, MD 20742

³ U.S. Naval Observatory, 3450 Massachusetts Ave., NW, Washington, DC 20392-5420

⁴ Biospheric Sciences Branch, Code 923, NASA Goddard Space Flight Center, Greenbelt, MD 20771

⁵ University of California at Berkeley; and Hat Creek Radio Observatory, 42231 Bidwell Road, Hat Creek, CA 96040

We previously reported Very Large Array and Berkeley-Illinois-Maryland Association (BIMA) array observations that suggested rotation of the SiO maser shell surrounding the long-period variable (LPV) in the R Aquarii binary system. In the present Very Long Baseline Array (VLBA) work, we report high spatial and spectral resolution observations of the $v = 1, J = 1 - 0$, SiO maser line that confirm our previous result and further suggest that the LPV maser shell is undergoing differential rotation. The 8–34 yr range of rotational periods resulting from differential rotation of the maser shell contains the ~ 18 yr period reported previously. The velocity structure of the VLBA data suggests a rotation symmetry axis oriented at a position angle of $\sim 150^\circ$. The differential rotation model can be envisioned as a series of nested thin spherical shells that have a common rotation axis; each thin shell is characterized by its radius, r , with the innermost shell rotating fastest and the outermost shell slowest, in accordance with an equatorial plane velocity law of the form $v \propto (1/r^q)^{1/2}$. We find that $q \approx 1.09$ is necessary to approximate the VLBA data, suggesting that the differential rotation is approximately Keplerian.

Accepted by ApJL

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or via WWW on <http://www.journals.uchicago.edu/ApJ/rapid.html>*

Cold HI in IRC +10 216

T. Le Bertre¹, E. Gérard²

¹ DEMIRM, UMR 8540, Observatoire de Paris, France

² ARPEGES, UMR 8644, Observatoire de Paris, France

With the recently refurbished Nançay Radiotelescope we have observed the HI 21 cm line in the direction of IRC +10216, a typical high mass-loss carbon star. We found HI in absorption indicating that the expanding

circumstellar gas may reach very low temperatures (≤ 4 K). The atomic gas could be the product of the photo-dissociation of molecular hydrogen in the outer envelope or result from a previous phase ($\geq 6 \times 10^3$ years ago) of mass loss when the star had a higher effective temperature than now.

Accepted by A&A

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Galactic mass-losing AGB stars probed with the IRTS. I

T. Le Bertre¹, M. Matsuura^{2,3,4}, J.M. Winters^{1,5}, H. Murakami², I. Yamamura², M. Freund^{2,6}, M. Tanaka^{2,7}

¹ DEMIRM, UMR 8540, Observatoire de Paris, France

² Institute of Space and Astronautical Science, Sagami-hara, Japan

³ University of Tokyo, Bunkyo, Tokyo, Japan

⁴ UMIST, Department of Physics, Manchester, U.K.

⁵ Max-Planck-Institut für Radioastronomie, Bonn, Germany

⁶ Goddard Space Flight Center, Greenbelt, U.S.A.

⁷ Department of Physics, Catholic University of America, Washington, U.S.A.

AGB mass-losing sources are easy to identify and to characterize in the near-infrared range (1–5 μ m). We make use of the near-infrared data acquired by the Japanese space experiment IRTS to study a sample of sources detected in the 2 celestial strips surveyed by the IRTS. Mass-loss rates and distances are estimated for 40 carbon-rich sources and 86 oxygen-rich sources of which 8 are probably of S-type. Although the sample is small, one sees a dependence of the relative contribution of the two kinds of sources to the replenishment of the interstellar medium (ISM) on the galactocentric distance. E.g. from 6 to 8 kpc, oxygen-rich sources in our sample contribute 10–12 times as much as carbon rich sources, whereas from 10 to 12 kpc, the latter contribute 3–4 times as much as the former. Therefore, one would expect a gradient in the composition of the ISM between 6 and 12 kpc from the Galactic Centre, especially in its dust component. Most of the replenishment (> 50%) by AGB stars is due to sources with mass-loss rate larger than $10^{-6} M_{\odot} \text{ yr}^{-1}$.

Accepted by A&A

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Sulfur, Chlorine, & Argon Abundances in Planetary Nebulae. IIB: Abundances in a Southern Sample

J.B. Milingo¹, K.B. Kwitter², & R.B.C. Henry³

¹ Department of Physics, Gettysburg College, Gettysburg, PA 17325

² Department of Astronomy, Williams College, Williamstown, MA 01267

³ Department of Physics & Astronomy, University of Oklahoma, Norman, OK 73019

We have undertaken in a large spectroscopic survey of over 80 planetary nebulae with the goal of providing a homogeneous spectroscopic database between 3600–9600 \AA , as well as a set of consistently determined abundances, especially for oxygen, sulfur, chlorine, and argon. In the current paper we calculate and report the S/O, Cl/O, and Ar/O abundance ratios for 45 southern planetary nebulae (predominantly Type II), using our own recently observed line strengths published in an earlier paper. One of the salient features of our work is the use of the NIR lines of [S III] $\lambda\lambda 9069, 9532$ coupled with the [S III] temperature, to determine the S^{+2} ionic abundance. We find the following average abundances for these objects: S/O=0.011 \pm .0064, Cl/O=0.00031 \pm .00012, and Ar/O=0.0051 \pm .0020.

Accepted by Astrophysical Journal Supplement.

Preprints can be obtained via WWW on <http://arXiv.org/abs/astro-ph/0109161>

Envelope tomography of long-period variable stars II. Method

Rodrigo Alvarez¹, Alain Jorissen¹, Bertrand Plez², Denis Gillet³, André Fokin⁴, and Maya Dedecker¹

¹ Institut d'Astronomie et d'Astrophysique, Université Libre de Bruxelles, C.P. 226, Boulevard du Triomphe, B-1050 Bruxelles, Belgium

² GRAAL, Université de Montpellier II, France

³ Observatoire de Haute Provence, France

⁴ Institute for Astronomy of the Russia Academy of Sciences, Moscow, Russia

A tomographic method is described that makes it possible to follow the propagation of shock waves across the photosphere of long-period variable stars. The method relies on the correlation of the observed spectrum with numerical masks probing layers of different atmospheric depths. The formation depth of spectral lines is derived from synthetic spectra of non-variable red giant stars. When applied to Mira stars around maximum light, the tomographic masks reveal that the deepest photospheric layers are generally characterized by blueshifted absorption lines (attesting their upward motion), whereas the uppermost layers generally exhibit redshifted absorption lines (indicating their infalling motion). Double absorption lines are found in intermediate layers, where the shock front is located. At later phases, the shock front is seen moving towards upper layers, until it leaves the photosphere.

Accepted by A&A

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or on <http://arXiv.org/abs/astro-ph/0109251>

Envelope tomography of long-period variable stars III. Line-doubling frequency among Mira stars

Rodrigo Alvarez¹, Alain Jorissen¹, Bertrand Plez², Denis Gillet³, André Fokin⁴, and Maya Dedecker¹

¹ Institut d'Astronomie et d'Astrophysique, Université Libre de Bruxelles, C.P. 226, Boulevard du Triomphe, B-1050 Bruxelles, Belgium

² GRAAL, Université de Montpellier II, France

³ Observatoire de Haute Provence, France

⁴ Institute for Astronomy of the Russia Academy of Sciences, Moscow, Russia

This paper presents statistics of the line-doubling phenomenon in a sample of 81 long-period variable (LPV) stars of various periods, spectral types and brightness ranges. When correlated with a mask mimicking a K0III spectrum, 54% of the sample stars clearly showed a double-peaked cross-correlation profile around maximum light, reflecting double absorption lines.

The LPVs clearly exhibiting line-doubling around maximum light with the K0III mask appear to be the most compact ones, the stellar radius being estimated from their effective temperatures (via the spectral type) and luminosities (via the period-luminosity relationship). It is not entirely clear whether or not this segregation between compact and extended LPVs is an artefact of the use of the K0III mask. Warmer masks (F0V and G2V) applied to the most extended and coolest LPVs yield asymmetric cross-correlation functions which suggest that line doubling is occurring in those stars as well. Although a firm conclusion on this point is hampered by the large correlation noise present in the CCFs of cool LPVs obtained with warm masks, the occurrence of line doubling in those stars is confirmed by the double CO $\Delta v = 3$ lines observed around $1.6 \mu\text{m}$ by Hinkle et al. (1984, ApJS 56, 1). Moreover, the H δ line in emission, which is another signature of the presence of shocks, is observed as well in the most extended stars, although with a somewhat narrower profile. This is an indication that the shock is weaker in extended than in compact LPVs, which may also contribute to the difficulty of

detecting line doubling in cool, extended LPVs.

Accepted by A&A

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Kinematic and morphological modeling of the bipolar nebula Sa2-237

*Hugo E. Schwarz*¹, *Romano R. L. Corradi*² and *Rodolfo Montez Jr.*³

¹ Cerro Tololo Inter-American Observatory, NOAO Casilla 603, La Serena, Chile

² ING, Apartado 321, E-38700 Sta. Cruz de La Palma, España

³ Dept. of Astronomy, University of Texas at Austin, USA

We present [OIII]500.7nm and H α + [NII] images and long-slit, high resolution echelle spectra in the same spectral regions of Sa2-237, a possible bipolar planetary nebula. The image shows a bipolar nebula of about 34" extent, with a narrow waist, and showing strong point symmetry about the central object, indicating it's likely binary nature. The long slit spectra were taken over the long axis of the nebula, and show a distinct "eight" shaped pattern in the velocity-space plot, and a maximum projected outflow velocity of $V_{exp} = 106 \text{ km}\cdot\text{s}^{-1}$, both typical of expanding bipolar planetary nebulae. By model fitting the shape and spectrum of the nebula simultaneously, we derive the inclination of the long axis to be 70° , and the maximum space velocity of expansion to be $\leq 308 \text{ km}\cdot\text{s}^{-1}$. Due to asymmetries in the velocities we adopt a new value for the system's heliocentric radial velocity of $-30 \text{ km}\cdot\text{s}^{-1}$. We use the IRAS & 21cm radio fluxes, the energy distribution, and the projected size of Sa2-237 to estimate it's distance to be $2.1 \pm 0.37 \text{ kpc}$. At this distance Sa2-237 has a luminosity of $340 L_\odot$, a size of 0.37 pc , and – assuming constant expansion velocity – a nebular age of 624 years. The above radial velocity & distance place Sa2-237 in the disk of the Galaxy at $z=255 \text{ pc}$, albeit with somewhat peculiar kinematics.

Accepted by ApJ

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Abundances of Recently Discovered Planetary Nebulae Towards the Galactic Bulge

*A. V. Escudero*¹ and *R.D.D. Costa*¹

¹ Departamento de Astronomia, IAG/USP, C.P. 3386, 01060-970 São Paulo - SP, Brasil

In this work we report spectrophotometric observations of a planetary nebulae sample towards the galactic bulge. A total of 44 PNe was observed, their physical parameters (electron density and temperature) were derived. Ionic abundances were calculated using a three-level atom model and abundances were derived through ionisation correction factors. Results show low abundance objects at high galactic latitudes, indicating a possible vertical gradient inside the bulge. A few objects with low N/O ratio were found, which could be originated from old, small mass progenitors.

Accepted by Astronomy & Astrophysics

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The discovery of the “21” μm and “30” μm emission features in Planetary Nebulae with Wolf-Rayet central stars

S. Hony¹, L.B.F.M. Waters^{1,2}, A.G.G.M. Tielens^{3,4}

¹ Astronomical Institute “Anton Pannekoek”, University of Amsterdam, Kruislaan 403, NL-1098 SJ Amsterdam, The Netherlands

¹ Instituut voor Sterrenkunde, Katholieke Universiteit Leuven, Celestijnenlaan 200B, B-3001 Heverlee, Belgium

¹ SRON Laboratory for Space Research Groningen, P.O. Box 800, NL-9700 AV Groningen, The Netherlands

¹ Kapteyn Astronomical Institute PO Box 800, NL-9700 AV Groningen, The Netherlands

We report the discovery of the “21” μm and “30” μm features in the planetary nebulae around the hydrogen-deficient stars HD 826 and HD 158269. The carriers of these features are known to be produced in outflows around carbon-rich stars. This discovery demonstrates that the bulk of the dust in these nebulae has been produced during a carbon-rich phase before the atmospheres of these stars became hydrogen poor. This is the first time that the “21” μm feature has been detected in any planetary nebula. It shows that once formed its carrier can survive the formation of the nebula and the exposure to the UV radiation of the hot central star. This means that the carrier of “21” μm feature is not transient: the absence of the feature sets limits on the production of its carrier.

Accepted by Astronomy & Astrophysics. 08/09/2001.

Preprints can be obtained by contacting hony@astro.uva.nl

New candidate planetary nebulae in M 81

L. Magrini¹, M. Perinotto¹, R.L.M. Corradi² and A. Mampase³

¹ Dipartimento di Astronomia e Scienza dello Spazio, Università di Firenze, L.go E. Fermi 5, I-50125 Firenze, Italy

² Isaac Newton Group of Telescopes, Apartado de Correos 321, 38700 Santa Cruz de La Palma, Canarias, Spain

³ Instituto de Astrofísica de Canarias, c. Vía Láctea s/n, 38200, La Laguna, Tenerife, Canarias, Spain

A 34'×34' field centred on the spiral galaxy M 81 has been searched for emission-line objects using the prime focus wide field camera (WFC) of the 2.54 m Isaac Newton Telescope (La Palma, Spain). A total of 171 candidate planetary nebulae (PNe) are found, 54 of which are in common with the ones detected by Jacoby et al. (1989). The behaviour of PNe excitation as a function of galactocentric distance is examined, and no significant variations are found. The PNe luminosity function is built for the disk and bulge of M 81, separately. A distance modulus of 27.92 ± 0.23 mag is found for disk PNe, in good agreement with previous distance measurements for M 81 (Jacoby et al. 1989; Huterer et al. 1995). Here you write your abstract

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Monitoring of long term behaviour of OH masers in semiregular variables: R Crt, W Hya and RT Vir

S. Etoka^{1,2}, L. Błaszkiewicz¹, M. Szymczak¹, and A.M. Le Squeren³

¹Toruń Centre for Astronomy, Nicolaus Copernicus University, PL-87100 Toruń, Poland

²Observatoire de Paris, F-92195 Meudon, France

³GRAAL, Université de Montpellier II, F-34095 Montpellier, France

We present and interpret the results of a long-term OH variability study of three semiregular stars, one type a (SRa), W Hya, and two type b (SRb), R Crt and RT Vir. The 1665 and 1667 MHz OH masers of the three semiregulars were observed at intervals in the period 1982 January – 1995 December using the Nançay radio telescope, and we searched for 1612 MHz emission. The OH maser profiles of the studied stars significantly deviated from a standard double-peaked profile. The timescale of profile changes in the two SRb stars R Crt and RT Vir was as short as a month. The OH profiles of the SRa star W Hya were much more stable but since November 1986 a very blue-shifted feature appeared at 1667 MHz. Our phase-lag measurements suggest that this feature comes from a detached OH shell of radius $\sim 3 \cdot 10^{16}$ cm. Faint 1612 MHz emission was found in W Hya only. Weak emission at velocities very close to the systemic velocity usually appeared during some intervals of high maser activity in R Crt and RT Vir and was almost always present in W Hya. For R Crt we estimated that this tangential emission disappeared when the kinetic temperature in the OH maser regions dropped below 150–200 K. For a few features, line narrowing and re-broadening were observed on timescales of 90–200 days. The linewidth was inversely proportional to the peak flux density, suggesting unsaturated amplification. Cyclic variations in the integrated flux density were observed in all the three stars. The OH variability curves were generally characterised by large amplitude ($4 - 6^m$) variations over 400–800 days superimposed with 100–300-day variations of $0.2 - 2^m$. Only the measured OH period of W Hya, of 362 ± 7 days, was in agreement with the optical period. The two SRb stars exhibited multi-periodic OH variability including with two statistically significant periods. The behaviour of their red- and blue-shifted emission was less correlated than in W Hya. The ratios of the flux densities at 1667 MHz to that at 1665 MHz in all the three stars were about 2 at epochs of high OH activity and usually increased during weak maser emission. Long term behaviour of the OH masers from W Hya resembled that of standard OH Miras, while that of R Crt and RT Vir suggested thin and clumpy envelopes where unsaturated emission was sustained in some clouds.

Accepted by Astronomy and Astrophysics

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Self-consistent coupling of radiative transfer and dynamics in dust-driven winds

S. Liberatore¹, J.-P.J. Lafon¹ and N. Berruyer²

¹ Observatoire de Paris-Meudon, DASGAL/UMR 8633, 92195 Meudon, France

² Observatoire de la Côte d’Azur, Laboratoire G.D. Cassini/UMR 6529, 06304 Nice, France

Models of stationary dust-driven winds of late-type stars are investigated. The flow is described successively using three models which couple, in spherical symmetry, the grain-gas dynamics in a self-consistent way with radiative transfer. Complete radiative transfer including multiple scattering, absorption and thermal emission is taken into account to determine the temperature of dust grains which in turn governs their thermal emission. The medium is not necessarily optically thin. The first model is used to check one classical hypothesis, that where the gas and the grains expand at the same velocity, the flow is described by a one-fluid model. This model is then improved in a second model, to include complete momentum coupling between gas and grains by friction. Finally, a third model includes grains and gas coupled by friction as well as the effects of inertial force on grains. By means of a numerical iteration, dynamics and radiative transfer are coupled in order to achieve a self-consistent solution in all cases. Even for fairly low non-zero optical depths, coupling of radiation with dynamics is found to be important for wind models which are all highly sensitive to input data. In conclusion, approximations (position and momentum coupling) for the dynamics should be relaxed.

Accepted by Astronomy & Astrophysics

Preprints can be obtained by contacting Stephane.Liberatore@obspm.fr

Nucleosynthesis of s-elements in zero-metal AGB stars

S. Goriely¹ and L. Siess¹

¹ Institut d'Astronomie et d'Astrophysique, Université Libre de Bruxelles, CP 226, B-1050 Brussels, Belgium

Contrary to previous expectations, recent evolutionary models of zero-metallicity stars show that the development of mixing episodes at the beginning of the AGB phase allows low- and intermediate-mass stars to experience thermal pulses. If these stars, like their metal-rich counterparts, also experience partial mixing of protons from the H-rich envelope into the C-rich layers at the time of the third dredge-up, an extensive neutron capture nucleosynthesis leads to the production of s-process nuclei up to Pb and Bi. Nucleosynthesis calculations based on stellar AGB models are performed assuming a parameterized H-abundance profile below the convective envelope at the time of the third dredge-up. Despite the absence of Fe-group elements, the large neutron flux resulting from the $^{13}\text{C}(\alpha, n)^{16}\text{O}$ reaction leads to an efficient production of s-process elements starting from the neutron captures on the C-Ne isotopes. Provided partial mixing of protons takes place, it is shown that population III AGB stars should be enriched in s-process elements and overall in Pb and Bi.

Accepted by A&A Letters

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or via WWW on <http://www-astro.ulb.ac.be/siess>*

K 413, a Star near the AGB in the Globular Cluster M 12

V. G. Klochkova¹ and N. N. Samus²

¹ Special Astrophysical Observatory, N.Arkhыз, 369167 Russia

² Institute of Astronomy of Russian Acad. Sci., 48, Pyatnitskaya Str., Moscow 109017, and Sternberg Astronomical Institute of Moscow University, 13, University Ave., Moscow 119899, Russia

CCD spectra obtained with the echelle spectrometer of the 6-meter telescope were used to determine, by the model atmospheres method, the fundamental parameters ($T_{\text{eff}}=4800\text{ K}$, $\log g=0.7$) and detailed chemical abundances for the star K 413, a member of the globular cluster M 12. The resulting value, $[\text{Fe}/\text{H}] = -1.38$, is the first metallicity determination for M 12 using high-resolution spectra.

The main characteristic feature of the star's atmospheric chemical abundance pattern is a large oxygen excess, $[\text{O}/\text{Fe}] \approx +2$. The s-process elements are probably slightly depleted compared to metallicity: $[\text{X}/\text{Fe}] = -0.04$ for yttrium and zirconium, $[\text{Ba}/\text{Fe}] = -0.12$ for barium. Abundances of the heavier elements: La, Ce, Nd, and Pr, do not differ, relative to iron, from the solar ones: $[\text{heavy}/\text{Fe}] = 0.0$. The europium excess, $[\text{Eu}/\text{Fe}] = +0.48$, is typical of members of low-metallicity globular clusters. The spectrum of K 413 shows, for the $\text{H}\alpha$ line, a variable absorption and emission profile. From its high luminosity and chemical abundance anomalies, we can suppose that K 413 is in an evolutionary stage after the AGB.

Accepted by Astronomy & Astrophysics

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Late AGB magnetic cycles: magnetohydrodynamic solutions for the Hubble Space Telescope planetary nebula rings

Guillermo García-Segura, José Alberto López, José Franco

Instituto de Astronomía-UNAM, Apdo Postal 877, Ensenada, 22800 Baja California, Mexico;

Email address: ggs@astrosen.unam.mx

The Hubble Space Telescope has revealed the existence of multiple, regularly spaced, and faint concentric shells around some planetary nebulae. Here we present 2(1/2)D magnetohydrodynamic numerical simulations of the effects of a solar-like magnetic cycle, with periodic polarity inversions, in the slow wind of an AGB star. The stellar wind is modeled with a steady mass-loss at constant velocity. This simple version of a solar-like cycle, without mass-loss variations, is able to reproduce many properties of the observed concentric rings. The shells are formed by pressure oscillations, which drive compressions in the magnetized wind. These pressure oscillations are due to periodic variations in the field intensity. The periodicity of the shells, then, is simply a half of the magnetic cycle since each shell is formed when the magnetic pressure goes to zero during the polarity inversion. As a consequence of the steady mass-loss rate, the density of the shells scales as r^{-2} , and their surface brightness has a steeper drop-off, as observed in the shells of NGC 6543, the best documented case of these HST rings. Deviations from sphericity can be generated by changing the strength of the magnetic field. For sufficiently strong fields, a series of symmetric and equidistant blobs are formed at the polar axis, resembling the ones observed in He 2-90. These blobs are originated by magnetic collimation within the expanding AGB wind.

Accepted by ApJ

Preprints can be obtained by www <http://arXiv.org/abs/astro-ph/0104154>

Infrared properties of planetary nebulae with [WR] central stars

S.K. Górnny¹, G. Stasińska², R. Szczerba¹ and R. Tylenda¹

¹ Copernicus Astronomical Centre, Rabiańska 8, 87-100 Toruń, Poland

² Observatoire de Paris-Meudon, DAEC, 92195 Meudon Cedex, France

We have gathered from the literature near and mid infrared (photometric and spectroscopic) data for Galactic planetary nebulae, with special attention to planetary nebulae surrounding Wolf-Rayet type central stars ([WR]PN). These data have been analyzed to obtain insight into the dust-properties of [WR]PN and their evolutionary status. We have found that a sizeable fraction of [WR]PN seems to contain hot dust (1000 – 2000 K), probably located in the winds of the central stars. The mean dust temperature is shown to decrease with decreasing [WC] spectral type. This is in line with suggestions that the [WC] sequence is an evolutionary sequence from late to early types. [WR]PN in different diagrams, when compared to those of non-[WR]PN, suggest that [WR]PN form a homogeneous class of planetary nebulae. There is an unusually large proportion of [WR]PN showing PAH features in their spectra.

Accepted by Astronomy & Astrophysics

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A Survey For Very Faint Planetary Nebulae in the SMC: I. Identification, Confirmation, and Preliminary Analysis

G.H. Jacoby-¹ and O. De Marco-²

¹ WIYN Observatory, P.O. Box 26732, Tucson, AZ, 85726

² Department of Astrophysics, American Museum of Natural History, Central Park West at 79th St, New York, NY 10024

Using the ESO 2.2m telescope with the 8K x 8K mosaic CCD, we have surveyed 2.8 square degrees ($\sim 1.6^\circ \times 1.7^\circ$) of the Small Magellanic Cloud (SMC) to search for faint planetary nebulae (PN). 34 PN were previously

known in this central region. We identified 25 new PN, all faint and spectroscopically confirmed. Most of these are spatially extended with typical diameters of ~ 1 pc, but a few as large as ~ 3 pc.

Based on the total number of PN previously known (~ 80), we can now estimate that there should be ~ 139 PN in the SMC to the limits of a survey like this one, which is complete to 6 mag down the planetary nebulae luminosity function (PNLF). For a complete survey (8 mag down the PNLF), there should be about 216 PN.

Because no new bright PN were found in this survey, the bright end of the PNLF remains unchanged from that reported by Jacoby, Walker, & Ciardullo (1990). Consequently, the distance modulus to the SMC, derived using the PNLF technique (Ciardullo et al. 1989), is still ~ 19.1 . However, a strong new feature is now evident in the PN brightness distribution that may be attributed to fast evolution of central stars evolving from a relatively young population. This feature may serve as an indicator of the ages of the PN progenitors.

The survey spectra that were used to confirm the candidates as PN also provide a clue to the nature of the very faint PN. Statistically, the fainter PN of our survey exhibit a high incidence ($\sim 28\%$) of strong [N II] emission (where $I([\text{N II}]/I(\text{H}\alpha)) > 1$) relative to the bright Sanduleak et al. (1978) sample ($\sim 6\%$) reported in Meatheringham & Dopita (1991a, 1991b), and comparable to the intermediate brightness Jacoby (1980) sample ($\sim 26\%$) reported by Boroson & Liebert (1989). This incidence of strong [N II] is higher than in the Kingsburgh & Barlow sample ($\sim 17\%$) of Galactic PN, despite the $\sim 3\times$ higher abundance of nitrogen in the Galaxy. We propose that the very faint SMC PN are selectively biased toward the chemically enriched Type I objects derived from younger, more massive progenitors and are partially obscured by their own dust. This brightness-dependent population change is also seen in the Large Magellanic Cloud.

Accepted by The Astronomical Journal. October 1, 2001.

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or via WWW on http://aloe.tuc.noao.edu/jacoby/smc-pn_1.ps.gz

The temperature structure of dusty planetary nebulae

G. Stasińska¹ and R. Szczerba²

¹ DAEC, Observatoire de Paris–Meudon, Meudon, France

² N. Copernicus Astronomical Center, Torun, Poland

We have analyzed the effects of photoelectric heating by dust grains in photoionization models of planetary nebulae. We have shown that this process is particularly important if planetary nebulae contain a population of small grains. The presence of such grains would solve a number of problems that have found no satisfactory solution so far: i) the thermal energy deficit in some objects inferred from tailored photoionization modelling; ii) the large negative temperature gradients inferred directly from spatially resolved observations and indirectly from integrated spectra in some planetary nebulae; iii) the fact that the temperatures derived from the Balmer jump are smaller than those derived from [O III] $\lambda 4363/5007$; iv) the fact that the observed intensities of [O I] $\lambda 6300$ are often larger than predicted by photoionization models. In presence of moderate density inhomogeneities, such as inferred from high resolution images of planetary nebulae, photoelectric heating would boost the temperature of the tenuous component, which would then better confine the clumps. The temperature structure of such dusty and filamentary nebulae would solve the long standing problem of temperature fluctuations posed by Peimbert (1967).

Accepted Astronomy & Astrophysics

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Conference Announcement

The Astronomy Department and the Institute for Nuclear Theory of the University of Washington are pleased to announce a conference on Stellar Abundances and Nucleosynthesis to be held at the University of Washington March 27,28,29 2002. This conference will celebrate the demonstration that some stars are deficient in heavy elements by Chamberlain and Aller as well as the discovery of the unstable element, technetium by P.W. Merrill, both in 1951. For further information see <http://int.phys.washington.edu/PROGRAMS/spring.html>

Topics that will be emphasized are: Abundances of light species, Mixing in stars Fe-peak elements, R-process and S-process elements, and Globular Clusters.

All participants must register at the www site given above.

George Wallerstein

Job opportunities

University of Leuven

The Institute of Astronomy of the University of Leuven in Belgium (for more information, see <http://www.ster.kuleuven.ac.be/>) has a vacancy for a postdoctoral researcher to work on the software development of the Danish Roemer/MONS fieldmonitor and star trackers. The succesful candidate will work part-time in Leuven (Belgium) and part-time in Arhus (Denmark). Besides the software development, 50science topics in asteroseismology. Applicants should hold a PhD in astronomy and have expertise in asteroseismology and programming. The position has an initial duration of one year and is twice renewable depending on the continuation of resources. Start date is 1/1/2002. Applications and/or inquiries can be sent to

Conny Aerts Instituut voor Sterrenkunde Celestijnenlaan 200 B B- 3001 Leuven Belgium tel: +32/16/32 70 28 fax: +32/16/32 79 99

The candidates are requested to provide the name and address of three referees.

Deadline for application is 1/11/2001.

Postdoctoral fellowship in stellar astrophysics at GRAAL, Montpellier University, France

The astrophysics research group at Montpellier University (France) MAY have a postdoctoral position starting October 1, 2002 (or shortly thereafter), for a period of 12 months (with a possible 6 months extension).

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, circumstellar envelopes, winds, planetary nebulae.

Further information may be obtained on:

<http://www.isteam.univ-montp2.fr/GRAAL/index.html>

Application are invited for this postdoctoral position in stellar physics and spectroscopy. Only candidates under 35 years before december 31, 2002, and from the following countries will be considered: Argentina, Australia, Brazil, Canada, Chile, China, Corea, Czech Republic, Hungary, India, Israel, Japan, Mexico, New-Zeeland, Norway, Poland, Romania, Russia, Slovakia, South-Africa, Switzerland, Turkey and USA.

The candidates must have a Ph.D. that has not been prepared in a french university.

The monthly salary will be around 1 830 Euros (~ 1 600 US \$),
starting October 1, 2002 (or in any case before the end of 2002).

Applications including a curriculum, a 1 or 2 pages research project and two references (name, address, and email) should be sent before December 15, 2001 to the director:

Gerard Jasniewicz
GRAAL cc072
Université de Montpellier II
F-34095 Montpellier cedex 5
France

or by email to gjasniew@graal.univ-montp2.fr

For more information please contact Bertrand Plez: plez@graal.univ-montp2.fr

ESA, Baltimore & Garching

Please be informed about the following ESA vacancies (supernumerary posts):

The Space Telescope Science Institute, Baltimore, is looking for two Astronomers (A2/A4 grade band of the Coordinated Organisations' salary scale)

Details can be found at http://www.esa.int/hr/VN_PERM/ESA046e.pdf

For further information please contact Dr. F. Duccio Macchetto at macchetto@stsci.edu

The Space Telescope European Coordinating Facility, Garching bei Muenchen, is looking for one Software Specialist (A2/A4 grade band of the Coordinated Organisations' salary scale)

Details can be found at http://www.esa.int/hr/VN_PERM/ESA045e.pdf

For further information please contact Prof. Piero Benvenuti at pbenvenu@eso.org