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Abstracts of recently accepted papers

Observations of SiO (v=0, 1, 2) J=3-2 and J=2-1 emisssion in late-type stars

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Observations of SiO v=0 to 2, J=3-2 transitions were carried out for 42 late-type stars containing SiO v=1, J=2-1 maser emission with the 14 m radio telescope at Taeduk Radio Astronomy Observatory (TRAO) during February 1995 and February 1996. Observations of the v=0 to 2, J=2-1 transitions in the same objects were performed within 40 days of the former observations using the same telescope. For SiO v=1, J=3-2 masers, the line was detected in 23 stars giving a detection rate of 55 %. 17 of them were new detections. For SiO v=2, J=3-2 masers, the line was detected in 7 stars, 4 of them being new detections. The v=2, J=3-2 line intensities were found at the expected intensity, unlike the anomalously weak emission seen previously in the rare v=2, J=2-1 maser. We also report the intensity ratios observed within the vibrational and rotational states.

Accepted by ApJS, 1998, April, 115. *Preprints can be obtained by contacting* cho@hanul.issa.re.kr *or via WWW on* http://www.issa.re.kr

Correlated nucleosynthesis of fluorine and s-process elements in asymptotic giant branch stars

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The production of fluorine and s-process elements in conditions simulating the helium-burning shell of asymptotic giant branch (AGB) stars is investigated from parametric one-zone nucleosynthesis calculations. Our calculations account for the correlation between the overabundances of these elements, as observed at the surface of S and C stars (Jorissen et al. 1992, A&A 261, 164). A primary supply of ^{13}C is, however, required to

produce ^{19}F and s-process elements at the observed levels through the operation of the ^{13}C(α,n)^{16}O neutron source. Our calculations allow to put strong constraints on this primary supply. They require a ^{13}C mass fraction of at least 0.003, with little sensitivity to the stellar conditions. This value is about 30 times larger than the secondary ^{13}C supply available at the end of the CNO cycle in solar-metallicity stars. The minimum ^{14}N mass fractions required are found to vary between about 6 10^{-4} and 0.01, depending on the temperature at which the fluorine production occurs.

Accepted by A&A. *Preprints can be obtained by contacting* Nami.Mowlavi@obs.unige.ch
or via WWW on http://obswww.unige.ch/~mowlavi/publications
or via anonymous ftp on obsftp.unige.ch, *file* /pub/mowlavi/sproc.ps.gz

Spectral variability of the binary HR 4049

Eric J. Bakker, David L. Lambert, Hans van Winckel, James K. McCarthy, Christoffel Waelkens, and Guillermo Gonzalez

The C I, Na I D, and Hα lines of the post-AGB binary HR 4049 have been studied. Na I D variability results from a photospheric absorption component ([Na/H]=-1.6 ± 0.2) which follows the velocity of the primary and a stationary, non-photospheric component. An emission component is attributed to the circumbinary disc, and an absorption component to mass-loss from the system with a velocity of 5.3±0.5 km/s.

The Hα profile varies with the orbital period. The two strong shell type emission peaks are identified as from one single broad emission feature with an absorption centered around -7.5 km/s. The intensity variations are largely attributed to a differential amount of reddening towards the Hα emitting region and the stellar continuum. The radial velocities suggest that the Hα emission moves in phase with the primary, but with a slightly lower velocity amplitude. From this we infer that the Hα emission comes from outside the orbit of the primary, but still gravitationally bound to the primary. Hα also shows a weak emission feature at -21.3 ± 3.5 km/s, which originates from the circumbinary disc and a weak absorption feature at -7.5 ± 1.6 km/s due to absorption by the circumbinary disc.

We propose two competing models that could account for the observed velocity and intensity variations of the Hα profile. Model I: light from the primary reflects on a localized spot near the inner radius of the circumbinary disc which is closest to the primary. Model II: Hα emission originates in the outer layers of the extended atmosphere of the primary due to activity. These activities are locked to the position of the primary in its orbit.

We discuss the similarities of variability and shape of the Hα emission of HR 4049 with those of early type T-Tauri stars (e.g SU Aur).

Accepted by Astronomy and Astrophysics. *Preprints can be obtained by contacting* ebakker@astro.as.utexas.edu
or http://viking.as.utexas.edu:8080/articles.html

The Optical Spectrum of the Planetary Nebula NGC 2440

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Wavelengths and identifications have been provided for approximately 300 lines between 3,660Å and 10,125Å in the spectrum of the bipolar planetary nebula NGC 2440. These lines measured with the Hamilton Echelle spectrograph at Lick Observatory and supplemented by published IUE results are used to construct diagnostic diagrams and derive ionic concentrations. The electron temperature indicated by [O III] is about 14,200 K; the electron density ~5,000 cm^{-1}. With aid of a standard model and an ionization correction factor method, we obtain a set of abundances which are compared with the sun and with results of previous studies. As with other

Peimbert Type I's, He and N are enriched as compared with the sun; C is likewise overabundant. NGC 2440 evolved from a progenitor star that was more massive than the sun. The central star temperature seems close to 180,000 K.

Accepted by PASP *For preprints, contact* hyung,aller@astro.ucla.edu or hyung@hanul.issa.re.kr

Hubble Space Telescope Observations of Planetary Nebulae in the Magellanic Clouds VII: Cycle 3 and HST Archive Narrowband [O III] 500.7 nm Imaging

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We present the continuation of our analysis of narrowband [O III] images, obtained using the Hubble Space Telescope, of planetary nebulae (PNs) in the Magellanic Clouds. Six objects, five in the Large Magellanic Cloud, are observed as part of the General Observer program. An additional fifteen objects are retrieved from the Hubble Space Telescope archive. The majority of the images are obtained prior to the first maintanence and refurbishment mission and are dominated by nebular [O III] 500.7 nm emission: the PN central stars are generally not seen. The raw images are deconvolved using 100 iterations of the Richardson-Lucy image restoration algorithm. The nebular dimensions and morphologies are determined. The nebular dynamical ages are derived using [O III] 500.7 nm expansion velocities from the literature. Using the techniques presented in Paper IV, the measured nebular ages are compared with theoretical evolutionary ages for H-burning and He-burning PN nuclei. Approximately 50% of the PN central stars are He-burners, in both the Large and Small Magellanic Clouds.

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Optical spectroscopy of the infrared source IRAS 09276+4454

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The chemical abundance curve and main parameters of the infrared source IRAS 09276+4454 associated with the high latitude luminous cold star SAO 42901 are determined using optical high resolution spectra. The effective temperature $T_{\rm eff} = 3400$ K was determined from band head intensity relations of TiO α-system. The abundances of 9 chemical elements in atmosphere of IRAS 09276+4454 were calculated with the model atmosphere method. The slight deficiency of iron was found $[{\rm Fe/H}]_\odot = -0.34$. Abundance of iron group elements V, Cr, Co, Ni slightly decreased relative to iron: $[{\rm X/Fe}]_\odot = -0.15$, abundances of s-process elements Y, Zr, Nd are increased relative to iron: $[{\rm X/Fe}]_\odot = +0.10$.

All parameters obtained for the source IRAS 09276+4454 agree with its belonging to the evolution phase close to AGB.

For 3 different observing moments strong variability of the radial velocity caused by binarity of the star studied is revealed.

Accepted by Bull. Special Astrophysical Observatory. *Preprints can be obtained by contacting* valenta@alba.sao.ru *or via WWW on* http://www.sao.ru/ valenta/IRAS09276/iras09276.html

The WC10 Central Stars CPD–56° 8032 and He 2–113: III. Wind Electron Temperatures and Abundances.

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We present a direct spectroscopic measurement of the wind electron temperatures and a determination of the stellar wind abundances of the WC10 central stars of planetary nebulae CPD–56°8032 and He 2–113, for which high resolution (0.15 Å) UCLES echelle spectra have been obtained using the 3.9 m AAT.

The intensities of dielectronic recombination lines, originating from auto–ionising resonance states situated in the $C^{2+} + e^-$ continuum, are sensitive to the electron temperature through the populations of these states which are close to their LTE values. The high resolution spectra allow the intensities of fine–structure components of the dielectronic multiplets to be measured. New atomic data for the autoionization and radiative transition probabilities of the resonance states are presented and used to derive wind electron temperatures in the two stars of 21 300 K for CPD–56°8023 and 16 400 K for He 2–113. One of the dielectronic lines is shown to have an autoionization width in agreement with the theoretical predictions. Wind abundances of carbon with respect to helium are determined from bound–bound recombination lines and are found to be C/He=0.44 for CPD–56°8023 and C/He=0.29 for He 2–113 (by number). The oxygen abundances are determined to be O/He=0.24 (by number) for CPD–56°8023 and 0.26 for He 2–113.

The effect of optical depth on the temperature and abundance determinations is investigated by means of a Sobolev escape probability model. We conclude that the optically thicker recombination lines can still be used for abundance determinations provided their upper levels are far from LTE.

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Crystalline silicates in Planetary Nebulae with [WC] central stars

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We present ISO-SWS spectroscopy of the cool dusty envelopes surrounding two Planetary Nebulae with [WC] central stars, BD+30 3639 and He 2-113. The lambda < 15 micron region is dominated by a rising continuum with prominent emission from C-rich dust (PAHs), while the long wavelength part shows narrow solid state features from crystalline silicates. This demonstrates that the chemical composition of both stars changed very recently (less than 1000 years ago). The most likely explanation is a thermal pulse at the very end of the AGB or shortly after the AGB. The H-rich nature of the C-rich dust suggests that the change to C-rich chemistry

did not remove all H. The present-day H-poor [WC] nature of the central star may be due to extensive mass loss and mixing following the late thermal pulse.

Accepted by Astron. Astroph. (Letters) *Preprints can be obtained by contacting* aaz@iapetus.phy.umist.ac.uk *or via WWW on* http://xxx.lanl.gov/abs/astro-ph/9802289

On the origin of the high velocity SiO maser emission from late-type stars

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We have undertaken toward 30 Mira or semi-regular variables and one OH/IR object highly sensitive observations of the $v = 1, J = 2 \rightarrow 1$ and $3 \rightarrow 2$ transitions of SiO simultaneously with observations of the $J = 1 \rightarrow 0$ transition of CO during three observing sessions in the period 1995 to 1996. As in our previous observations of 1994, we observe that for several stars the SiO profiles exhibit unusually broad wings which sometimes exceed the terminal velocity of the expanding circumstellar envelope traced by the thermal CO emission. We have discovered a clear dependence of the SiO wing emission on the optical phase. These wings are probably due to peculiar gas motions and varying physical conditions in relation with the stellar pulsation. However, we cannot exclude other mechanisms contributing to the observed wings. In particular, SiO turbulent motions for the semi-regular variables or the asymmetric mass loss mechanism may play a role. We conclude that the SiO wing emission is due to masing processes and that this emission very likely arises from the inner part of the circumstellar envelope.

Accepted by Astron. and Astrophy. *Preprints can be obtained by contacting* herpin@observ.u-bordeaux.fr
paper can be obtained on the WWW http://adress/directory.html obtained by anonymous ftp ftp://adress/directory/publication.

HST V-band Imaging of the Bipolar Proto-Planetary Nebula IRAS 17150-3224

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We report HST WFPC2 imaging of the bipolar proto-planetary nebula IRAS 17150-3224. We find a series of concentric arcs superimposed on the two reflection nebular lobes, similar to those observed in AFGL 2688. This suggests that periodic mass loss enhancement is a common phenomenon in the AGB phase. The near circular shape of the arcs suggests that mass loss is spherically symmetric during the AGB phases and that the bipolar morphology develops only after the end of the AGB phase. The possible evolution in morphology from proto-planetary nebulae to planetary nebulae is discussed.

Accepted by Astrophysical Journal (letters). *Preprints can be obtained by contacting* kwok@iras.ucalgary.ca

Temporal Variations of Mid-IR Spectra in Late-Type Stars

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New multi-epoch, mid-infrared (8-13 μm) spectrophotometric observations are presented for 30 late-type stars. The observations were collected over a four year period (1994-1997), permitting an investigation of the mid-infrared spectral shape as a function of the pulsation cycle (typically 1-2 years). The spectra of stars with little excess infrared emission and those with carbon-rich dust show the least spectral variability, while stars with evidence for dusty, oxygen-rich envelopes are most likely to show discernible variations in their spectral profile. Most significantly, a large fraction of variable stars with strong 9.7 μm emission features show clear spectral profile changes which repeat from one cycle to the next. The significant sharpening of the silicate feature near maximum light can not be fully explained by heating and cooling of the circumstellar dust shell during the pulsational cycle, suggesting that the dust optical properties themselves must also be varying. In addition, the appearance of a narrow emission feature near the silicate peak for a few stars may require the production of especially "pure" silicate dust near maximum light. The general narrowing of the silicate feature observed may reflect the evolution of the pre-existing dirty grains whose surface impurities have been evaporated off when the grain temperature rises preceding maximum light. An improved theory of dust formation which can explain the observed changes in the grain properties around a single, pulsating star may lead to a definitive explanation for the diversity of silicate emission profiles observed amongst oxygen-rich, late-type stars.

Accepted by the Astrophysical Journal. *Preprints can be obtained by contacting* monnier@ssl.berkeley.edu

A Morphological Study of Planetary Nebulae

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University of Calgary

We have produced simulated images of 110 planetary nebulae using the ellipsoidal shell model. This process has allowed us to remove the projection effects from the morphological classification of planetary nebulae, and provided quantitative measures of the intrinsic asymmetries of the nebulae. It is shown that the morphology of most planetary nebulae can be reproduced with a pole-to-equator density ratios of 0.1 to 1. Many planetary nebulae also show a modest departure from axial symmetry. Contrary to previous findings by Khromov & Kohoutek (1968), the sky orientation of planetary nebulae in this sample is consistent with a purely random distribution. Extremely bipolar nebulae (e.g. those of butterfly shape) points to a steep density profile in the AGB envelope, and are more likely to be Type I (high helium and/or nitrogen abundance) nebulae. We found evidence that these nebulae are likely to have more massive progenitors, and are at a more advanced stage of dynamical evolution.

Accepted in Astrophysical Journal Supplements

Dissertation abstracts

Cool Wolf-Rayet central stars and their planetary nebulae

Orsola De Marco

Thesis work conducted at: University College London, London, UK

Ph.D dissertation directed by: M.J. Barlow and P.J. Storey

Ph.D degree awarded: October 1997

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The research presented in this thesis is concerned with the properties of Wolf–Rayet (WR) central stars and their planetary nebulae (PNe). The analysis was carried out on high (R=30 000) and intermediate (R=5 000) resolution optical and UV spectra of a sample of WR central stars and their PNe. The emphasis has been the determination of consistent stellar and nebular results via the use of a range of empirical and theoretical methods.

The definition of a robust classification system for central stars with WC spectra was proposed, consistent with the scheme of Smith et al. (1990, ApJ 358, 229) designed for massive WC stars. Our WC classification criteria have been thoroughly compared with past schemes and, in particular, WO and WCE classifications have been unified.

Nebular and stellar parameters and distances of the [WC10] central stars CPD–56°8032, He 2–113, M 4–18 and of the peculiar [WC9] SwSt 1 were determined. Distances were given a special consideration since they are the key to determining the range of luminosities of WR central stars. For instance, the difficulty in reconciling distances, luminosities and PNs characteristics for the spectroscopic twin [WC10] central stars He 2–113 and M 4–18, indicates the possibility of a slower evolution for M 4–18; this demonstrates that two identical WR central stars might follow different evolutionary paths.

From nebular analysis it has emerged that the most likely origin of the broad pedestal observed at the base of the Balmer profiles of CPD–56°8032, He 2–113 and M 4–18 is nebular rather than stellar emission as had been proposed by Leuenhagen et al. (1996, AA 312, 167). This reinstates WC central stars within their former hydrogen–free status so that the overlap between hydrogen–rich and hydrogen–poor central stars sequences is no longer obvious. Extremely high nebular C/H number ratios have been derived for CPD–56°8032 and He 2–113. Carbon enrichment can be expected in a variety if situations, however nebular C/H number ratios for M 4–18 and SwSt 1 are much lower showing that a high C/H ratio is not a prerogative of WR central stars. If carbon enrichment of the PN is at the hand of the stellar wind, the size and characteristics of the PN and the central star might explain the lack of carbon enrichment. Nebular parameters and abundances can be reproduced by photoionization modeling for the PNe of M 4-18 and SwSt 1 using WR model atmospheres, while modeling of CPD–56°8032 and He 2–113 was hampered by dust-gas competition in the ionized regions and no clear results could be obtained.

HST images, presented here for the first time, revealed that CPD–56°8032, He 2–113 and SwSt 1 are irregular and compact, while the PN of M 4-18 has a more developed morphology and, with a lower electron density than either of the other three, is certainly older, despite its spectrum being almost identical to that of He 2–113. No halo or second larger shell, which might reveal an association with the *born–again* scenario (Iben et al. 1983, ApJ 264, 605) is observed in these images.

Stellar recombination line analysis and non–LTE WR wind modeling (Hillier 1990, AA 231, 111) were used to determine stellar wind abundances and wind parameters. The use of dielectronic recombination lines was used for the determination of the wind electron temperature in the C II line forming region of 5 [WCL] stars (17 000 to 20 000 K). By comparison with the electron temperatures predicted by the wind models, this constitutes the first confirmation of the assumption of radiative equilibrium in the winds of WR stars. Optical depth effects on C II bound–bound recombination lines were shown *not* to preclude their use for abundance determination.

It is argued that evidence is accumulating towards the fact that there are different evolutionary sequence for all post–AGB WC central stars of PN, in the sense that it does not appear that the [WC] stars are *either all* post–AGB *or all* created though a *born–again* scenario.

Meetings, Conferences and Summer Schools

mm-Interferometry Summer School

IRAM will be organizing a "mm Interferometry Summer School" in September 1998. The school will take place at the IRAM headquarters, in Grenoble, from Sep. 14th to Sep. 18th. The school is intended for PhD students and scientists with or without *a priori* knowledge of radio interferometry techniques. It will focus on special aspects of interferometry at millimeter wavelengths, using the Plateau de Bure interferometer as an example.

A preliminary program and schedule is available on the IRAM Web page (http://iram.fr/school/school.html). A visit to the Plateau de Bure interferometer is foreseen as an integral part of the school.

The number of participants will be limited to a maximum of 40 persons. Participation to the school will be free of charges, but participants are expected to pay their own travel and lodging expenses. Cheap hotel accommodation ($\sim$ 130 FF/night, about 20 US$/night) is available on the University Campus. Lodging is also possible in Grenoble (transport time is about 15–20 min by public transportation). IRAM will provide information and assistance for hotel reservations. IRAM may be able to provide very limited financial support for a few participants.

Interested scientists should complete the pre-registration form (http://iram.fr/school/school-form.ps) and send it to

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Mrs A.Jost -- C.Berjaud
Scientific Secretariat
IRAM
300, Rue de la Piscine
F-38406 Saint Martin d'Heres Cedex
FRANCE
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or by E-Mail to berjaud@iram.fr (please specify "Summer School" in the topic field).

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IAU Symposium No 191

ASYMPTOTIC GIANT BRANCH STARS

August 27th - September 1rst, 1998
Le CORUM, Montpellier, France

Web Site : http://www.dstu.univ-montp2.fr/GRAAL/agb98-1.html

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SECOND ANNOUNCEMENT

The IAU Symposium N 191 "Asymptotic Giant Branch Stars" will take place in Montpellier, France, from August 27 to September 1, 1998. It will be held in the Auditorium 'Einstein' within the CORUM (the Congress Center and Opera House) located in the very heart of Montpellier, just a step from the historical center of this thousand-year-old city, the Capital of Languedoc-Roussillon. The meeting, at the very end of August, will benefit from the pleasant ending summer of the South of France.
Please, note that the meeting will start on :
Thursday August 27, at 2 PM.

From our Pre-registration campaign, the response of the community is impressive (~ 280 pre-registrations by Feb. 04), and now we are planning for a meeting with about
250 participants.

Hereafter you will find informations on :
- Registration
- Meeting Format
- Call for papers, Abstract Booklet, Proceedings
- Accommodation (Hotel)
- Travel information
- Social Program
- SUMMARY : IMPORTANT DEADLINES

For an updated copy of this announcement and additional information, visit our web page at:

http://www.dstu.univ-montp2.fr/GRAAL/agb98-1.html
In particular, you will find therein an updated scientific programme.

This E-mail is preferably sent to all those who have pre-registered.
Please share this information with your colleagues who may not have received this E-mail announcement.