# THE AGB NEWSLETTER

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

No. 41 — 01 September 1997

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

*Abstracts of recently accepted papers*

## A radial velocity study of the companion to the central star of Abell 35

*A. A. Gatti*[1], *J. E. Drew*[1], *S. Lumsden*[2], *T. Marsh*[3], *C. Moran*[3], *and P. Stetson*[4]

[1] Imperial College of Science, Technology and Medicine, Blackett Laboratory, Prince Consort Road, London, SW7 2BZ, UK.

[2] Anglo-Australian Observatory, PO BOX 296, Epping, NSW 2121, Australia

[3] Department of Physics, Southampton University, Southampton S09 5NH, UK

[4] Dominion Astrophysical Observatory, 5071 West Sacnich Road, Victoria, BC V8X 4M6, Canada

We report the results of a radial velocity study of LW Hya, the cool companion to the sub-dwarf central star of the planetary nebula Abell 35. Estimates for its radial velocity have been obtained by cross-correlation with radial velocity standards for five epochs of observations sampling periods of the order of days and decades. We find that any radial velocity variation on periods shorter than 30 days cannot possess a semi-amplitude greater than 5 km $s^{-1}$. Also, with the exception of a limited number of possible periods not covered by our sampling frequency we can exclude radial velocity variations of semi-amplitude larger than $\sim$ 8 km $s^{-1}$ up to periods of approximately 30 years. On the other hand, short period, small semi-amplitude ($\sim$ 5 km $s^{-1}$) radial velocity variations have been observed in the blue spectral region and possibly, with a smaller semi-amplitude ($\sim$ 2 km $s^{-1}$), in the red. The photometric period of $0.766 \pm 0.001$ days, that has been associated with the rotation of the star, is consistent with them, although other periods cannot yet be ruled out.

**Accepted for publications by** Monthly Notices of the Royal Astronomical Society.
*For preprints please contact* gattiaa@ic.ac.uk

## Spectral atlas of the symbiotic star MWC 560 for the region between $H_\beta$ and $H_\alpha$

*E.L. Chentsov, V.G. Klochkova, G.A. Mal'kova*

Special Astrophysical Observatory RAS, Nizhnij Arkhyz, Karachai-Cherkessia, 357147 RUSSIA

An atlas of the spectrum of the unique symbiotic system MWC 560 = V694 Mon, which was taken in January 1995 with the CCD echelle spectrometer of the 6 m telescope is presented. The atlas covers a region from 4780 Å to 6580 Å, the spectral resolution limit is 0.3 Å, the signal–to–noise ratio is 80–100. About 400 emission lines of 27 species are identified.

**Accepted by Bull. Special Astrophys. Obs., vol.43, 1997.**

*Preprints can be obtained by contacting:* valenta@alba.sao.ru

# Dust shells around carbon Mira variables

*M.A.T. Groenewegen*[1], *P.A. Whitelock*[2], *C.H. Smith*[3], *F. Kerschbaum*[4]

[1] Max-Planck Institut für Astrophysik, Karl-Schwarzschild Straße 1, D-85740 Garching, Germany

[2]South African Astronomical Observatory, P.O. Box 9, 7935 Observatory, South Africa

[3]Dept. of Physics, University College, ADFA, Canberra ACT 2600, Australia

[4]Institut für Astronomie der Universität Wien, Türkenschanzstraße 17, A-1180 Wien, Austria

The spectral energy distributions and mid-infrared spectra of 44 carbon Mira variables are fitted using a dust radiative transfer model. The pulsation periods of these stars cover the entire range observed for carbon Miras. The luminosities are derived from a period-luminosity relation. Parameters derived are the distance, the temperature of the dust at the inner radius, the dust mass-loss rate and the ratio of silicon carbide to amorphous carbon dust. The total mass-loss rate is derived from a modified relation between the photon momentum transfer rate ($L/c$) and the momentum transfer rate of the wind ($\dot{M}\ v_\infty$). Mass-loss rates between $1 \times 10^{-8}$ and $4 \times 10^{-5}$ $M_\odot$ yr$^{-1}$ are found. We find good correlations between mass-loss rate and pulsation period ($\log \dot{M} = 4.08\ \log P - 16.54$), and mass-loss rate and luminosity ($\log \dot{M} = 3.94\ \log L - 20.79$). These relations are not independent as we assumed a $P - L$-relation. If we had assumed a constant luminosity for all stars there still would be a significant relation between $\dot{M}$ and $P$. The dust-to-gas ratio appears to be almost constant up to periods of about 500 days, corresponding to about 7900 $L_\odot$, and then to increase by a factor of 5 towards longer periods and higher luminosities. A comparison is made with radiation-hydrodynamical calculations including dust formation. The mass-loss rates predicted by these models are consistent with those derived in this paper. The main discrepancy is in the predicted expansion velocities for models with luminosities below ~5000 $L_\odot$. The radiation-hydrodynamical calculations predict expansion velocities which are significantly too large. This is related to the fact that these models need to be calculated with a large C/O ratio to get an outflow in the first place. Such a large C/O ratio is contrary to observational evidence. It indicates that a principle physical ingredient in these radiation-hydrodynamical calculations is still missing. Possibly the winds are "clumpy" which may lead to dust formation on a local scale, or there is an additional outwards directed force, possibly radiation pressure on molecules.

**Accepted by MNRAS**

*For preprints, contact* groen@mpa-garching.mpg.de*, or look at* http://www.mpa-garching.mpg.de/~groen/groen.html

# Mid-Infrared (8–21$\mu$m) Imaging of Proto-Planetary Nebulae

*Aditya Dayal*[1,2], *William F. Hoffmann*[1], *John H. Bieging*[1], *Joseph L. Hora*[3], *Lynne K. Deutsch*[4], *Giovanni G. Fazio*[5]

[1]Steward Observatory, University of Arizona, Tucson, AZ 85721

[2]present address: JPL/Caltech, MS 183-900, 4800 Oak Grove Drive, Pasadena, CA 91109

[3]Institute for Astronomy, 2680 Woodlawn Drive, Honolulu HI 96822

[4]Astronomy Department, Boston University, Boston, MA 02215

[5]Center for Astrophysics, 60 Garden Street, Cambridge MA 02138

We present mid–infrared (8–21$\mu$m) images of thermal dust emission from two proto–planetary nebulae (PPNe), IRAS 07134+1005 and IRAS 22272+5435, which show a strong 21$\mu$m emission feature. Both of the sources are well resolved and show evidence for axial symmetry. From our images we calculate temperature and optical depth maps and estimate the abundance of the 11$\mu$m and 21$\mu$m feature carriers. In both sources the dust temperatures range from $\sim$ 160–200 K. The optical depths in IRAS 07134 are about a factor of 3 lower than those in IRAS 22272, but the emission is optically thin in both sources. Our analyses of the feature–to–continuum ratios suggests that 0.5–5% of the carbon in these objects may be in the form of large PAH molecules. We construct optically thin, axially symmetric cylindrical shell models to simulate the observed mid–IR morphologies and spectra, and calculate nebular masses of 0.26 $M_\odot$for IRAS 07134 and 0.42 $M_\odot$for IRAS 22272. Though the mid-IR emission primarily comes from warm ($T \approx 190$ K) dust, our models require a significant cooler dust ($T \approx 80$ K) component to fit the observed mid– and far–IR spectral energy distributions.

**Accepted for publication by the Astrophysical Journal**
*For preprints, please contact* adayal@lb6.jpl.nasa.gov

# 3-Dimensional MHD Modeling of Planetary Nebulae: The Formation of Jets, Ansae and Point-Symmetric Nebulae Via Magnetic Collimation

*Guillermo García-Segura*[1,2]

[1] Instituto de Astronomía-UNAM, Apdo Postal 70-264, 04510 México D. F., Mexico

[2] Now at Instituto de Astronomía-UNAM, Apdo Postal 877, Ensenada, 22830 Baja California, Mexico

3-dimensional, megneto-hydronynamical simulations of the formation and evolution of planetary nebulae are discussed, confirming that planetary nebula jets and ansae can be obtained by magnetic collimation of their central, post-AGB, fast winds. Jets and ansae form at the polar regions because of the magnetic tension produced by the magnetized winds. Exterior density distributions anisotropic with latitude (e.g. accretion disks, wind compressed disks, etc.) are not required inside this framework. We found that the expansion velocity of the jets and ansae coincides with the wind velocity of the post-AGB phase. It is proposed that the formation of "attached" and "detached" ansae involves, as a simplified model, two and three winds, respectively. It is also shown that, the formation of rotating jets and point-symmetric nebular shapes can be the result of magnetic collimation around a precessing star. If the precession is caused by a tidal force, only a wide binary system is required.

**Accepted by ApJ Letters**

*Preprints can be obtained by contacting* ggs@astroscu.unam.mx

# 3-Dimensional MHD Modeling of Planetary Nebulae: The Formation of Jets, Ansae and Point-Symmetric Nebulae Via Magnetic Collimation

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**Accepted by ApJ Letters**

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# The WC10 Central Stars CPD–56°8032 and He 2–113: I. Distances and Nebular Parameters

*Orsola De Marco, M. J. Barlow and P. J. Storey*

Dept. of Physics and Astronomy, University College London, Gower Street, London WC1E 6BT, UK

We present the results of an analysis of the the WC10 central stars CPD–56°8032 and He 2–113 and of their surrounding planetary nebulae (PN). UCL Echelle Spectrograph spectra with a resolving power of R = 50 000, covering the wavelength range 3600–9500 Å were obtained for both objects.

Expansion and radial velocities are derived from the nebular Balmer lines. Reddenings were derived from the observed H$\alpha$/H$\beta$ decrements, as well as from the ratio of the radio free-free and H$\beta$ fluxes. We find that E(B–V) = 0.68 for CPD–56°8032 and E(B–V) = 1.00 for He 2–113. The bolometric luminosity is found to be 2820 $D^2$(kpc) $L_\odot$ for CPD–56°8032 and 2290 $D^2$(kpc) $L_\odot$ for He 2–113. We have used a calibration based on Magellanic Cloud Wolf-Rayet central stars to estimate a distance of 1.35 kpc to CPD–56°8032 and 1.50 kpc to He 2–113. A comparison of the radial velocities of interstellar Na I D-line absorption components with Galactic rotation curve predictions for each line of sight yields distances which agree within the uncertainties with these values.

We also present deconvolved pre–COSTAR *HST* H$\beta$ images from which we derive nebular angular sizes of 1.65×2.1 arcsec for CPD–56°8032 and 1.4×1.1 arcsec for He 2–113. ¿From our spectra, nebular electron temperatures of 8800 K and 8400 K are derived for CPD–56°8032 and He 2–113, respectively, while an electron density of $6\times10^4$ $cm^{-3}$ is determined for both nebulae. Sulphur is found to have a near–solar abundance in both nebulae, and the nebular nitrogen abundances are also close to solar. The nebular C/O abundance ratios (determined with the help of low–resolution *IUE* spectra) are found to be equal to 13 for CPD–56°8032 and 10 for He 2–113 respectively, significantly higher than the values normally found for galactic PN. We find no detectable amounts of hydrogen in either stellar wind.

**Accepted by MNRAS**

*Preprints can be obtained by contacting* od@star.ucl.ac.uk

# R Aquarii: First Detection of Circumstellar SiO Maser Proper Motions

*D. A. Boboltz*[1,2], *P. J. Diamond*[1] *& A. J. Kemball*[1]

[1] National Radio Astronomy Observatory, Soccoro, NM 87801 [2] Virginia Polytechnic Institute and State University, Blacksburg, VA 24061

We have made the first detection of circumstellar SiO maser proper motions in the envelope of a late-type star. Using the Very Long Baseline Array (VLBA), we have obtained observations at four epochs of the 43-GHz, $v = 1, J = 1 - 0$ SiO maser emission towards the Mira variable in the symbiotic binary R Aqr. The maser emission has a ring-like structure ∼31 mas across with a slight elongation in the north-south direction. We find that the emission changes significantly over a timescale of ∼1-2 months with almost no similarity in structure for timescales ≥6 months. Our observations show that over a 98-day period the masers have an average inward proper motion of ∼1 mas. This contraction of the ring implies an infall velocity of ∼4 km $s^{-1}$ for the SiO masers in the circumstellar envelope.

**Accepted by The Astrophysical Journal Letters**

*Preprints can be obtained by contacting* dboboltz@fritz.haystack.edu
*or via WWW on* http://dopey.haystack.edu/staff/dboboltz/index.html

# The role of ionization energy during the planetary nebula ejection

*Amos Harpaz*[1,2]

[1] Department f Physics, University of Haifa at Oranim, Tivon 36006, ISRAEL

[2] Department of Physics, MIT, 6-211, 77 Massachusetts Av., MA 02139, USA

The conditions for release of the ionization energy in the envelope of an Asymptotic Giant Branch (AGB) star are studied. It is shown that the recombination, that releases the ionization energy, also causes a sharp drop of the opacity, thus enabling the released energy to flow outward freely. The possibility that the ionization energy, when released, drives the ejection of Planetary nebula (PN) is discussed.

Tests suggested to validate the hypothesis that the ionization energy drives PN ejection are examined, and it is found that these tests are not sensitive to details of the hypothesis they are supposed to validate.

**Accepted by Astrphysical Jurnal**
*Preprints can be obtained by contacting* phr89ah@vmsa.technion.ac.il The nature of OH/IR stars in the galactic centre

# The nature of OH/IR stars in the galactic centre

*J.A.D.L. Blommaert*[1,2,3], *W.E.C.J. van der Veen*[4], *H.J. Van Langevelde*[5], *H.J. Habing*[1] *and L.O. Sjouwerman*[6]

[1] Strrewacht Leiden, P.O. box 9513, 2300 RA Leiden, The Netherlands
[2] ISO Science Operations Centre, Astrophysics Division, Space Science Dept. of ESA, Villafranca, PO Box 50727, 28080 Madrid, Spain
[3] CNRS, Institut d'Astrophysique de Paris, 98bis, Blvd Arago, 75014 Paris, France
[4] Columbia University, Dept. Of Astronomy, 538 West 120$^{\rm th}$ Street, New York, NY 10027, USA
[5] Joint Institute for VLBI in Europe, P.O. Box 2, 7990 AA Dwingeloo, The Netherlands
[6] Onsala Space Observatory, 439 92 Onsala, Sweden

We report on infrared observations of stars in a field of 30′ near the galactic centre. All these objects were previously detected as OH (1612 MHz) maser sources. For a large fraction of these stars variability data are available from a VLA monitor programme. This makes it possible to correct the IR measurements for variability. Corrections for interstellar extinction are also applied. The resulting infrared colours, periods and luminosities are compared with results for other samples of OH/IR stars and it is shown that the galactic centre stars are similar to the same type of objects in the bulge of the Galaxy but that more luminous (and thus younger) stars exist in the centre. The question of the existence of two distinct populations of OH/IR stars near the galactic centre is addressed, but the limited number of stars inhibits a firm conclusion. We do find that when the sample is divided according to OH expansion velocity, the dust–to–gas mass loss ratio, which depends on metallicity, is on average twice as high for the high expansion velocity group as for the low expansion velocity stars. The luminosities and the number density of the low expansion velocity stars are consistent with them being an extension of the bulge population, whereas the high expansion velocity group contains brighter sources and is more likely to be a population intrinsic to the galactic centre. The previously proposed period–luminosity (PL–) relation for OH/IR stars can be studied with this sample. We find that the OH/IR stars significantly deviate from the PL–relation and argue that the OH/IR stars have evolved away from the PL–relation. It was found that non–variable OH/IR stars are often associated with peculiar IR sources.

**Accepted by Astronomy and Astrophysics.**
*Preprints can be obtained by contacting* jblommae@iso.vilspa.esa.es

# Inhomogeneous planetary nebulae: Carbon and Oxygen abundances

*A.F. Kholtygin*

Astronomical Institute, St. Petersburg University, St. Petersburg, 198904 Russia

We reconsider the problem of the difference between the abundances of carbon and oxygen in galactic planetary nebulae (PN) derived from the intensities of the recombination and collisionally excited lines. This discrepancy can be explained by an inhomogeneity of the PNe and an overestimation of the weak line intensities. The formulae for calculation of the nebular line intensities in presence of both temperature and density fluctuations are given. The intensities of the forbidden [OIII] lines, the CII, CIII and CIV recombination lines and the CIII] $\lambda$ 1909 UV intercombination doublet for different values of the mean electron temperature $T_0$ in PNe and the *rms* temperature variation $\boldsymbol{t^2}$, are calculated. Results of these calculations are used to find the values of $T_0$ and $\boldsymbol{t^2}$ which allow to provide the best fit of the observed and calculated line intensities (taking into account the observational errors). In most cases, the obtained values of $T_0$ appear to be significantly smaller than ordinarily used for the abundance determinations $T_{\rm e}$([OIII]), while $\boldsymbol{t^2} < 0.16$. The carbon and oxygen abundances for more than 70 PNe are calculated. For these PNe average chemical abundances are evaluated separately for nebulae of type I, II and III. For the first, we found C/H=$6.67 \cdot 10^{-4}\,{\rm cm}^{-3}$ and O/H=$5.74 \cdot 10^{-4}4\,{\rm cm}^{-3}$. For the second they are C/H=$8.94 \cdot 10^{-4}\,{\rm cm}^{-3}$ and O/H=$6.36 \cdot 10^{-4}\,{\rm cm}^{-3}$. For the third we obtained C/H=$3.94 \cdot 10^{-4}\,{\rm cm}^{-3}$ and O/H=$4.79 \cdot 10^{-4}\,{\rm cm}^{-3}$. Results of the fitting of the line intensities for the NIII $\lambda$4640 and NIV] $\lambda$1486 lines are also given.

**Accepted by Astronomy and Astrophysics**

*Preprints can be obtained by contacting* afk@aispbu.spb.su

*Messages*

# Request: Preprints/Reprints on Carbon Stars for Annual Reviews Article

*Jill Knapp and George Wallerstein*

Dear Colleagues

George Wallerstein and I are writing an article on Carbon Stars for Annual Reviews. We would be most grateful for reprints/preprints. George is dealing with the stars and I with mass loss, but obviously there's a lot of overlap. Please send papers to:

George Wallerstein
Department of Astronomy, FM-20 Seattle, WA 98195
USA
wall@orca.astro.washington.edu

Jill Knapp
Department of Astrophysical Sciences
Princeton University
Princeton, NJ 08544
USA
gk@astro.princeton.edu

Thank you!

# Non-Equilibrium Radiative Hypersonic Flows: Theoretical, Observational and Numerical Aspects in Astrophysics and Industry

## Mt Ste Odile, France
## 22-25 September 1997

## ——— UPDATED PROGRAMME ———-

Presentations will be given in either French (F) or English (E); discussion welcome in either language. The times below INCLUDE 10 MINUTES each for discussion. The proceedings will be published in English.

More information: http://astro.u-strasbg.fr/ odile/colloque97.html

## MONDAY 22 SEPTEMBER

1500-1505 (F) Introduction to the School - JEAN-PIERRE LAFON (Obs. Paris-Meudon)

*I. Hypersonic Flows* (Chair: ARIANE LANCON)

1505-1605 (F) Theory (a. Generalities, Fluid Mechanics, Shock Waves) - E. HUGUET (Obs. Paris-Meudon)

1605-1705 (F?) Theory (b. Non-equilibrium Media, Radiative Transfer, Hydrodynamical-Radiative Coupling) - R. BRUN (CNRS Marseille)

1705-1730 Break for Coffee, Tea, etc.

1730-1820 (F?) Numerical Simulations (a. Generalities, Conservative Formulation, Finite Volumes) - [Replacment for A. Vincent]

1820-1910 (F) Numerical Simulations (b. Illustrations, Ionisation) - C. MARMIGNON (ONERA)

1915 Dinner .... free time

## TUESDAY 23 SEPTEMBER

*II. Applications in Space Industry* (Chair: DENIS GILLET)

0900-1000 (F) Atmospheric Reentering Vehicules - ALAIN BROC (Obs. Paris-Meudon)

1000-1100 (?) Theoretical Aspects (Shock Tubes, Chemical Kinematics, Wind Chamber Tests) - L. MARRAFFAT (ESTEC/ESA)

1100-1130 Break

*III. Stellar Winds: General* (Chair: Rubens FREIRE)

1130-1230 (E) Observations and Diagnostics - HENNY LAMERS (Univ. Utrecht)

1230 Lunch, Guided Tour of Ste Odile

1500-1600 (E) Theory - UWE SPRINGMANN (Univ. Munich), or H.Lamers

1600-1630 Break

*IV. Wind Instabilities and Variability on Small and Large Scales* (Chair: FARROKH VAKILI)

1630-1720 (F) Observations - SEBASTIEN LEPINE (Univ. de Montreal)

1720-1810 (E) Theory and Simulations - STAN OWOCKI (Univ. Delaware)

1810 Dinner, Wine-Tasting in a Nearby Cellar

## WEDNESDAY 24 SEPTEMBER

*V. Dust in Stellar Winds* (Chair: JOACHIM KOEPPEN?)

0900-0950 (F) Formation in a Hostile Environment - JEAN-PIERRE LAFON (Obs. Paris-Meudon)

0950-1040 (F) Chemistry and nucleation - NICOLE BERRUYER (OCA, Nice)

1040-1110 Break

*VI. Disk Formation* (Chair: TBD)

1110-1200 (F) Young Stars - PIERRE BASTIEN (Univ. de Montreal)

1200 Lunch

1500-1550 (E) Massive Rotating Stars - STAN OWOCKI (Univ. Deleware)

1550-1620 Break

*VII. Interaction of Winds in Different Stages and with Their Environment* (Chair: ROMUALD TYLENDA)

1620-1710 (F) Massive Evolved Stars - NICOLE ST-LOUIS (Univ. de Montreal)

1710-1800 (F) Low-Mass Evolved Stars - AGNES ACKER (Univ. Strasbourg)

1900 Diner special (bring your talents....)

## THURSDAY 25 SEPTEMBER

0900-1000 (E) Theory and Modelling - GARRELT MELLEMA (Univ. Stockholm)

1000-1030 Break

*VIII. Colliding Winds in Binary Systems* (Chair: MICHAEL FRIEDJUNG?)

1030-1120 (F) Observations - TONY MOFFAT (Univ. de Montreal)

1120-1210 (E) Theory - ROLF WALDER (Univ. Zurich)

1210 Lunch

*IX. Round Table* (Moderator: YVES GROSDIDIER, Univ. de Montreal / Univ. de Strasbg)

1400-1530 (F,E) The Important Things I Have (or Have Not) Learnt at this School - THE STUDENTS

1530-1535 Closing Remarks (A. ACKER, A. MOFFAT)