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Thierry Forveille and Claudine Kahane

Abstracts of recently accepted papers

Numerical models and our understanding of aspherical Planetary Nebulae

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The status of numerical hydrodynamical models for Planetary Nebulae is reviewed. Since all of the numerical work is based on the interacting winds model, we start out with a description of this model and give an overview of the early analytical and numerical models. Subsequently we address the numerical models which include radiation effects, first of all the ones which neglect any effects of stellar evolution. These 'constant environment' models are shown to closely match typical observed nebulae, both in images and kinematic data. This shows that the basic generalized interacting winds model gives a good description of the situation in aspherical PNe. Next we discuss models that do include the effects of stellar and fast wind evolution. This introduces several new effects, the most important of which are the formation of a surrounding attached envelope, and the modification of the expansion of the nebula, which helps in creating aspherical PNe very early on in their evolution. The ionization of the slow wind also leads to a gradual smoothing out of its aspherical character, working against aspherical PNe forming in later stages. Finally we discuss some applications of the model. These are the predicted X-ray map, and possible explanations for temperature fluctuations and hot haloes.

To appear in Asymmetrical Planetary Nebulae, Annals of the Israel Physical Society, Vol. 11, eds. A. Harpaz and N. Soker *For preprints, contact* gam@ast.ma.umist.ac.uk

HCN Emission from Bright Carbon Stars: The Ground State Masers and Peculiar Broad Features

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We have investigated $H^{12}CN$ v=0 J=1-0 emission from six optical carbon stars. All of them show unusual components of narrow velocity widths superposed on the broad component, except RY Dra. The spike pattern does not agree with that expected from the hyperfine structure of HCN in LTE. All the spikes show strong time variability in intensity, with time scales of the order of months in the case of W Ori and Y CVn. Linear polarization probably exists in the spikes of the two stars. We have also monitored Y CVn in the $H^{13}CN$ v=0 J=1-0 line simultaneously with the $H^{12}CN$. The prominent spike previously reported by us has been absent during the present observation period. Furthermore, there is no relation between the variations of the two emission lines.

We have concluded that the spike components found in W Ori and Y CVn are the ground state masers in the $H^{12}CN$ line. The same is probably true for the other three stars. Emission due to the F=2-1 hyperfine component is most likely amplified. The masers are preferentially seen in carbon stars with relatively low rates of mass loss of around 10^{-7} $M_\odot$ yr^{-1}. Their frequency of occurrence is at most 50% among optical carbon stars which show a broad emission component and have a mid-infrared color of log(12F25/25F12) less than -0.77.

The broad components as well show some peculiar features. Brightness temperatures for all the six stars become extremely high if we adopt HCN envelope sizes found in the literature. UU Aur has shown a considerable change in the intensity as well as in the line shape. The anomalous enhancement in the bluer part in Y Tau may be related to an asymmetry in the innermost region of the envelope. Some modifications are needed in the current understanding of HCN emission from optical carbon stars. In addition, RY Dra seems to posses a very HCN-rich envelope compared to Y CVn and shows a blueshifted absorption-like dip which is unusual for optical carbon stars.

Accepted by ApJ, scheduled for 20 February 1995 issue *For preprints, contact* izumiura@yamabuki.u-gakugei.ac.jp

Stellar evolution of low and intermediate-mass stars: I. Mass loss on the AGB and its consequences for stellar evolution

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We have performed extensive stellar evolution calculations for initial masses between 1 and $7M_\odot$ all the way from the main sequence through the AGB towards the stage of white dwarfs.

Mass loss has been taken into account with different descriptions for the RGB, AGB and post-AGB phase. On the AGB we considered mass loss with a formula based on the dynamical calculations of Bowen (1988) for the atmospheres of Mira-like stars. Our results are consistent with empirical initial-final mass relations.

It is shown that hot bottom burning and mass loss are closely connected. The overluminosity as well as the nucleosynthesis of hot bottom burning models can depend sensitively on mass loss.

Furthermore, we discuss the influence of mass loss on the internal structure reached at the tip of the AGB, and emphasize that post-AGB timescales will depend strongly on the AGB history, i.e. on the initial mass and the applied mass-loss law.

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Hot bubble and slow wind dynamics in PNe (Radiation-gasdynamics of PNe V)

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This paper looks into various aspects brought to light by numerical work on the generalized interacting winds model for planetary nebulae. First, a detailed comparison between radiative and non-radiative models is made, showing that one's naive expectations of the effects of radiative heating and cooling are not always true. Secondly, we consider the evolution of the slow wind after it has gotten ionized. It is found that the initial aspherical density distribution is smoothed out after ionization, thus requiring the aspherical nebula to be formed within the first few thousand years of PN evolution. Thirdly, the nature of the flow in the hot bubble is investigated. Both one and two-dimensional numerical models show strong signs of instabilities or turbulent flow in the hot bubble. Although observationally hard to prove or disprove this turbulent structure is critically examined. It is found that although the turbulence is not a numerical artifact, the full three-dimensional picture will most definitely differ from what is found in two dimensions. The implications for the interpretation of the models are discussed. Finally, the issue of the soft X-ray emission from PNe is considered. It is found that soft X-rays originate mainly from the thin interface between the hot bubble and the actual nebula.

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SiO maser survey of the galactic bulge IRAS sources: the 7< $|b_{II}|$ <8°strips

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We have surveyed Galactic bulge IRAS sources in the strips between - -15 < l <15 °and 7 < $|b|$ <8 °in the SiO J=1-0 v=1 and 2 transitions. The sources were selected from the IRAS Point Source Catalogue based on the IRAS 12 and 25 μm flux densities, extracting dust enshrouded objects at a distance of 8 kpc. SiO masers were detected in 53 of the 91 sources surveyed in these strips. Because distances to the IRAS sources in these strips have been known from the period-luminosity relation and periods of intensity variation at infrared wavelengths measured by others, the contamination by foreground sources in the sample can be checked relatively easily and the uncertainty in deriving physical parameters of the bulge is minimized. The detection rate of SiO masers does not depend much on the infrared colors in the selected color range (logarithm of the IRAS 25 to 12 μm flux density ratio between - -0.15 to 0.3) and the detection rate increases with the 12 μm flux density of the IRAS sources. It has been found that the intrinsic SiO maser intensity depends weakly on the mass loss rate for the bulge and disk SiO maser sources. No systematic difference of the SiO maser properties is found between bulge and disk sources. The radial velocities in the northern strip are shifted systematically from those in the southern strip by about 50 kms^{-1} . If this velocity shift is interpreted as due to a tilt of the bulge rotation axis to the Galactic longitude circle, the tilt angle of the rotation of the bulge would be 18±14°. The angular rotation velocity of the bulge stellar system is 7.310^{-8} radian yr^{-1} (implying the rotation period of 8.6 10^7 yr). A Galactic top-view of the distribution and the velocity vectors of the bulge SiO masers is given.

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SiO maser survey of the galactic bulge IRAS sources: II. the $4 < |b_{II}| < 5°$strips

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We have surveyed Galactic bulge IRAS sources in the strips between - -15 $< l <$ 15°and 4 $< |b| <$5°in the SiO J=1-0 v=1 and 2 transitions. The sources were selected from the IRAS Point Source Catalogue based on the IRAS 25/12 μm flux density ratio, extracting dust-enshrouded objects at a distance of about 8 kpc. The SiO masers were detected in 62 of 93 sources surveyed in these strips. The JHKL photometric data (1.2, 1.6, 2.2 and 3.4 μm) were also obtained for 85 sources.

Because distances to the IRAS sources in these strips are not known, we have evaluated the distance based on the observed luminosity. The probability of the object being a bulge source is calculated assuming that the luminosity function of these infrared sources is the same as that of previously observed $|b|$=7-8 °sources. The contamination due to foreground sources in the sample is minimized by excluding sources with the bulge probability less than 50%. The SiO maser properties of the $|b|$=4-5 °sources are found to be very similar to those of $|b|$ = 7-8 °sources. No systematic difference between bulge and disk sources is found for the SiO J=1-0 v=2/1 intensity ratio. The average rotation rate of the bulge stellar system for the $|b|$=4-5 °sources is found to be 10.8 [± 2.6] km.s^{-1}.deg^{-1}, indicating no sign of increase of the rotation rate at this strip compared with the rate obtained for the $|b|$=7-8 °sources. On the contrary, the velocity dispersions of stars, 91.0 ± 9.5 km.s^{-1}, for the $|b|$=4–5 °sources seems appreciably larger than the dispersion, 72.5 ± 8.9 km.s^{-1} obtained for the $|b|$=7-8 °sources. A small, systematic velocity shift of the radial velocities is found between the south and north strip sources. If this shift is interpreted as due to a tilt of the bulge, the tilt angle of the bulge rotation axis to the Galactic circle would be, which is slightly smaller than the value obtained for the $|b|$=7–8 °sources.

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Spectroscopy of Evolved Stars in the Near-Infrared: Explorations Beyond the AGB

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We present spectra taken between $\lambda = 0.9 - 1.3$ μm for a sample of evolved stars ranging from Mira variable stars to planetary nebulae. An evolution can be seen from the absorption spectra of the late-type stars to the emission line spectra of the planetary nebulae. We compare emission line strengths for objects ranging from T_{eff} = 30,000 K to 200,000 K, and we use infrared and visible line ratios to determine densities and temperatures in the emission line regions. We examine the four factors that are most important to determining relative ion strengths – stellar temperature, evolutionary status, excitation mechanism, and clumpiness. It is found that clumps appear to be common, and that shocks are very important to the excitation and shaping of planetary nebulae. We also find that the strength of the low ionization and molecular emission lines decreases with age, and we use a filling factor analysis to show that this evolution is caused by a decrease in the amount of low ionization material close to the star.

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Time dependent behaviour and physical conditions of the LMC planetary nebula N66

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Optical and UV spectrophotometric data, for the planetary nebula N66 in the Large Magellanic Cloud, gathered in the 1987-1994 interval are analyzed. The central star, which had a featureless weak continuum, has developed intense W-R features and P-Cygni profiles that were not present before 1990. He- and N-rich material, processed during the CNO cycle, is being ejected; the ejecta are very H-deficient, with $X/Y < 0.1$. A spectral type of WN4.5 is confirmed for the central object. From the optical broad emission lines a wind velocity of about 3,000 km s^{-1} is found in fair agreement with the value v_∞ = 4,200 km s^{-1} found from the C IV λ1550 P-Cygni profile. The intensity of the UV and optical continua have been increasing systematically and the absolute stellar visual magnitude, M_V, has changed from +1.24 mag in 1987 August to −2.23 mag in 1994 March. The stellar temperature has diminished from $\geq$ 120,000 K to $\simeq$ 50,000 K while t! he radius has increased from 0.37 $R_\odot$ to 1.7 $R_\odot$. The object is probably undergoing a final helium shell flash. The present evolutionary stage of N66 is discussed. On the other hand, the intensities of the nebular emission lines have shown no significant variation in the last 20 years. The nebular chemical abundances, calculated by considering no temperature fluctuations, are He/H = 0.116 ± 0.004, log C/H = 7.45 ± 0.10, log N/H = 7.95 ± 0.12, log O/H = 8.24 ± 0.06, log Ne/H = 7.70 ± 0.06, log Ar/H = 6.12± 0.04, and log S/H = 6.70 ± 0.10. N66 shows He and N enrichment while C appears very depleted relative to LMC H II regions and planetary nebulae. while the other heavy element abundances (O, Ne, Ar and S) are slightly lower than in H II regions confirming that N66 is a Type I planetary nebula. No evidence of C enrichment of the stellar atmosphere due to third dredge-up episode is detected.

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Stellar evolution and mass loss on the asymptotic giant branch

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Mass loss dominates the stellar evolution on the Asymptotic Giant Branch. The phase of highest mass-loss occurs during the last 1–10% of the AGB and includes the so-called Miras and OH/IR stars. In this review I discuss the characteristics and evolution of especially Miras, with the emphasis on the mass loss evolution. The mass-loss rates vary both on long and short time scales: the short-term variations are likely linked to luminosity variations associated with the thermal-pulse cycle. There are indications that the highest mass-loss rates are only reached for relatively young stars with massive progenitors. The influence of mass loss in the post-AGB phase is also discussed.

Review presented at Edinburgh, "Circumstellar Matter", August 1994 *For preprints, contact* azijlstr@eso.org

Narrow emission line O VI planetary nebulae nuclei

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We present a study of the characteristics of four planetary nebulae (PNs) with O VInuclei: NGC 1501, IC 1297, IC 1747, and K1–16. They have high temperature central stars with well–separated narrow O VIλ3811, 34 emission lines. We present intensities of the nebular lines, equivalent widths of the stellar lines, and, where possible,plasma diagnostics and nebular ionic abundance. In order to test the evolutionary stage of the central stars relative to the nebular properties we calculate Zanstra temperatures and luminosities. We find that the stars have similar physical characteristics and thus represent approximately the same phase of post–asymptotic giant branch (P–AGB) evolution. Their O VI absolute fluxes correlate reasonably well to the central stars positions on the HR diagram.

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Adaptive Optics Imaging of Proto-planetary Nebulae: Frosty Leo and the Red Rectangle

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Near infrared, 0.1" resolution images of the bipolar nebulae Frosty Leo and Red Rectangle have been obtained with an adaptive optics system developed at the University of Hawaii. In both cases evidence is found supporting a binary star formation mechanism for the nebulae.

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^{26}Al and circumstellar envelopes

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The effects of the radioactive decay of ^{26}Al on the circumstellar envelopes of AGB stars are analyzed. The γ-rays emitted by the product nucleus ^{26}Mg escape most envelopes but the β-decay positrons are stopped and can ionize and heat the gas. The ionization may produce observable effects in C-rich circumstellar envelopes, particularly if the photospheric ^{26}Al abundance is as large as inferred from measurements of live ^{26}Al in the primitive solar nebula or the observations of interstellar 1.8 MeV γ-rays. For the nearby carbon star IRC +10216, the measured abundance of the molecular ion HCO^+ provides an upper limit of about 4×10^{-3} for the photospheric ^{26}Al/^{27}Al ratio, somewhat smaller than required by the meteoritic data but consistent with pre-solar SiC grains with about the same ^{12}C/^{13}C ratio.

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Near-Infrared Polarization in the Bipolar Outflow OH 0739−14

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We present linear polarization observations of the bipolar outflow source OH 0739−14 from 1.2 to 3.6 μm. The high levels of polarization ($\sim$47% in the bipolar lobes) and the angles of the vectors in the outflow lobes imply that the 1.2–3.6 μm polarization is due to single scattering by dust grains of light from the central source or from its immediate vicinity. Our polarization measurements, combined with phase-lag measurements of variability in the nebula by Kastner et al. (1992), tightly constrain the inclination angle i between the bipolar axis and the plane of the sky to be $35° \leq i \leq 37°$. We observe the percentage polarization of the bipolar lobes to be constant with wavelength from 1.2 to 3.6 μm, which rules out any significant contribution by unpolarized emission, such as tiny grain emission, to the 3.6 μm emission. We propose to explain the $K - L'$ color of the nebula as due to illumination by both the central star and by thermal emission from dust in a surrounding circumstellar shell with a dust temperature of 600–1000 K. Using this model we find a relatively high minimum scattering optical depth at 3.75 μm of $\tau\omega > 0.1$. This is difficult to reconcile with Rayleigh scattering, which would then imply optically thick scattering at wavelengths of 1.2 and 1.65 μm, in contrast to the observations. We also find that the albedo of the grains at 3.75 μm and probably at 2.2 μm is higher than predicted for normal interstellar grains.

Accepted by AJ. *For preprints, contact* shure@amber.ifa.hawaii.edu

Possible Detection of ^{14}CO in the Carbon Star IRC+10216

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The ^{14}CO $J = 1-0$ spectral line was observed in the molecular envelope surrounding the carbon star IRC+10216. The $[^{13}CO]/[^{14}CO]$ ratio in the envelope is 224 ± 47.

Accepted by Astrophysical Journal Letters. *For preprints, contact* gw@research.att.com

News Jobs

Receiver Scientist at Dept. of Physics and Astronomy, University of Calgary

The University of Calgary has an opening for a physicist/astronomer with experience in mm/submm receiver technology. This is a two- year position funded by the Canadian Space Agency in support of the ODIN satellite. ODIN is an international project involving Sweden, Canada, France, and Finland, with the primary objective of observing the submm lines of water, oxygen, and other interstellar molecules. The successful candidate will be residing in Sweden for the period of employment and is expected to participate in the satellite instrument development and testing, and to provide technical advice to the Canadian Astronomy ODIN Working Group.

Candidates for the position should have a Ph.D. degree astronomy or physics. Salary is expected to be in the range of Can $50,000 to $55,000 per year, with a benefits package and living/travel allowance. Preference will

be given to candidates who will be available to take up the position in early 1995. Applicants should send to the address below a resume and the names, addresses and phone numbers of three professional references. Deadline for applications is January 10, 1995. AAE/EOE.

Attn: Dr. Sun Kwok Dept. of Physics and Astronomy
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Professorship in Observational Astrophysics at Uppsala University

The department of astronomy at Uppsala University, Uppsala Astronomical Observatory, invites applications for a full professorship in Astronomy, especially Observational Astrophysics. The starting date for appointment is June 1, 1995.

The main scientific interests at the department are within the areas Solar System Research, Stellar Atmospheres and Envelopes, Galactic Structure and Evolution and Galaxies and Observational Cosmology. The present research groups in these fields carry out both theoretical and observational work. The staff consists of about 10 PhD:s; in addition there are 15 graduate students and technical staff. Observational resources available include ESO, including the Swedish ESO Submillimetre Telescope, the NOT 2.5 m telescope and the Swedish Solar Station on La Palma, the ESA satellites (including HST), Onsala Space Observatory with a 20 m radio telescope, the Kvistaberg Observatory (with a 100/135/300 cm Schmidt telescope).

The professorship entails a three hour a week teaching duty, mainly on the graduate level, which may partly be made as supervision of graduate students. The candidates should be able to lead and supervise research in observational astrophysics, and be willing to undertake the leadership of the department as a whole. The annual salary is negotiable, within the range USD 40,000 - 60,000, excluding health insurance, pensions etc payed by the employer. Uppsala University is committed to equal opportunity; women are strongly urged to apply.

The University of Uppsala is one of the oldest in Europe and has a college town atmosphere. It is located 70 km north of Stockholm and about a 30 minutes drive from the international airport.

Interested candidates should contact

Uppsala Astronomical Observatory,
Professor Bengt Gustafsson, director,
Box 515,
S-751 20 Uppsala, Sweden

email: Bengt.Gustafsson@astro.uu.se

as soon as possible for further information, including a description on what a formal application should contain and how it will be evaluated. Formal applications should have reached

Registrator,
Box 256,
S-751 05 Uppsala, Sweden

before December 22, 1994.