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Abstracts of recently accepted papers

H_2O maser emission from semiregular variables

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107 semiregular variables of spectral type M have been observed in the H_2O $6_{16} \rightarrow 5_{23}$ line at 22.235 GHz with the 100 m Effelsberg radio telescope and maser emission has been detected in 23 objects, of which 10 are new detections. The maser semiregulars show redder infrared colours than similar non−maser semiregulars. The H_2O masers are usually associated with semiregulars of late spectral types and substantial mass loss rates. A great variety of H_2O maser spectra from single through double−peaked to complex profiles is observed, showing strong variations in the profiles and in the relative intensities of separate features. Generally, emission from the blue part of the velocity interval is stronger than emission from the red part. The H_2O outflow velocities range from 20 to 80% of the terminal expansion velocities. A wide range of H_2O luminosities ($L_{H_2O} = 0.6\ 10^{40} - 6\ 10^{43} s^{-1}$) is observed but on average the H_2O luminosity of semiregular stars is lower than that of Miras. A correlation between the H_2O maser luminosity and mass loss rate seems to exist, which extends a similar relationship found among Miras and OH/IR stars towards smaller mass loss rates.

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Radiative transfer in axisymmetric circumstellar dust shells

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A non-spherical dust shell radiative simulation, aiming both at analysing the existing data on evolved stars and at preparing the interpretation of the scheduled high angular resolution imaging, is described. The calculated radiative equilibrium derives from a Monte Carlo method. The exact solution of the transfer is thus computed for different wavelengths. Results are obtained for different modellings with peculiar axisymmetric dust density distributions. The broad band spectra, the brigthness distribution of the shell as a fonction of wavelength and view angle and the corresponding visibility maps, display typical observable properties. In a first attempt the spectrum and the visble image of the Red Rectangle are reproduced with a flared disc.

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BD+30°3639: The infrared spectrum during post-AGB stellar evolution

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We present a radiative-transfer calculation which reproduces the infrared spectrum of the planetary nebula BD +30°3639. We calculate the transfer process through absorption and scattering in a spherical-symmetric multi-grain dust shell. The emission of transiently heated particles is taken into account, as well as polycyclic aromatic hydrocarbons. We obtain an acceptable fit to most of the spectrum, including the PAH infrared bands. At submillimetre wavelengths the observed emission is larger than the model predicts, indicating that large dust conglomerates ("fluffy grains") may be needed as an additional constituent. The fit favour a distance of ≥ 2 kpc, which implies that BD +30°3639 has evolved from a massive progenitor of several solar masses. A low dust-to-gas mass ratio is found in the ionised region. The calculations yield an original mass-loss rate of 2×10^{-4} $M_\odot$ yr^{-1} on the Asymptotic Giant Branch. Using this mass-loss rate, we calculate how the infrared spectrum has evolved during the post-AGB evolution. We show in particular the evolution of the IRAS colours during the post-AGB evolution.

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The Formation of Bipolar Planetary Nebulae and Close White Dwarf Binaries

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We systematically investigate the effects of binary interactions on the formation and shaping of planetary nebulae (PNe) and the various evolutionary channels leading to the formation of close white dwarf binaries, in particular cataclysmic variables (CVs), double degenerate binaries (DDs) and potential progenitors of Type Ia supernovae (SNe). Using Monte-Carlo simulations, we explore the consequences of various different binary mass-ratio distributions, different initial – final mass relations, different population parameters (like age and metallicity), and different theoretical assumptions concerning the modeling of the common-envelope phase.

Our results agree well with observations and — where comparable — with previous studies. Our main conclusions are: (1) The morphology of 34 to 43 % of all planetary nebulae is affected by binary interactions, if we assume that 50 % of all stellar systems are binaries with orbital periods less than ~ 100 yr. (2) The main types of binary interactions considered (gravitational focusing, common-envelope ejection and binary merger) are all of comparable importance. (3) Massive binaries are slightly more likely to produce bipolar PNe, provided that the initial mass-ratio distribution is biased towards a mass ratio near unity. (4) The orbital periods of close white dwarf binaries which experienced a common-envelope (CE) phase extend to longer orbital periods than found in earlier studies, because the binding energy of the CE of initially wide systems is reduced. (6) Best agreement with observations, in particular the fraction of PNe with close binary nuclei and the birth rates of CVs and DDs, is obtained if the process that leads to the ejection of CEs is very efficient. (7) The rate of mergers of two CO white dwarfs with a total mass larger than the Chandrasekhar mass, possibly leading to a Type Ia supernova, is marginally consistent with the observational SN Ia rate, although not in our best model. (8) Our simulations support the initial – final mass relation proposed by Han, Podsiadlowski & Eggleton (1994) and the use of PNe as a standard distance candle.

Accepted by MNRAS. *For preprints, contact* Zhanwen Han at zhanwen@mail.ast.cam.ac.uk. *For preprint of another paper "A possible criterion for envelope ejection in asymptotic giant branch or first giant branch stars" (MNRAS 270, 121-130, 1994), please contact me too.*

On the propagation of sound waves in a stellar wind traversed by periodic strong shocks

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It has been claimed that in stellar winds traversed by strong shocks the mechanism for driving the wind by sound wave pressure cannot operate because sound waves cannot propagate past the shocks. It is shown in this paper that sound waves can propagate through shocks in one direction and that this is a sufficient condition for the sound wave pressure mechanism to work. A strong shock amplifies a sound wave passing through it and can drag the sound wave away from the star. It is immaterial for the sound wave pressure gradient that the sound wave vector points towards the star. Since the strong shocks drag the sound waves away, the star itself is the source for the sound waves propagating towards it in the local fluid frame of the wind.

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Adaptive optics imaging of the Frosty Leo nebula

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Images of IRAS 09371+1212 (the Frosty Leo nebula) have been obtained in the near infrared (K' band) with the COME-ON+ adaptive optics system. These high resolution pictures confirm the formerly established characteristics and unveil unknown details of the nebula. For the first time the central star is directly resolved against the disk-like structure of the equatorial plane. Though large scale isophotes are symmetric, short scale isophotes are asymmetric with respect to the star. This may be the signature of perturbations by a companion to the central object. Although no direct imaging of the binary system has been possible, this interpretation leads to the derivation of dynamic parameters that appears consistent with an unseen companion of $1.4M_{\odot} < M_{\rm comp} < 2.6M_{\odot}$. It is established that the source of the mass loss is the directly imaged star. The nebula is thus composed of a binary system embedded in a circumbinary disk. The presence of the disk is not clearly explained yet. A complete explanation of the system history is not yet available but we suggest some possible scenarii.

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The distribution of dust around Asymptotic Giant Branch stars

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A sample of 13 Asymptotic Giant Branch stars (AGB stars) were observed in the submm continuum at 761 and $1100\mu m$ with the James Clerk Maxwell Telescope (JCMT, Mauna Kea, Hawaii). Eleven sources were detected in at least one of the two wavelength bands. Mapping observations were attempted for five sources. Some of our sources were also measured at $1250\mu m$ by Walmsley et al. (1991) and good agreement was found except for three sources: IRC+10216, W Hya and OH26.5+0.6. The differences for IRC+10216, however, can be understood as caused by a rather steep density law in its dust shell; for W Hya there is evidence for submm variability.

The radial dust distribution in the circumstellar envelopes was derived by combining the submm observations with near IR and IRAS observations obtained from the literature and by fitting the data with an optically thin and spherically symmetric dust shell model. In addition, for three sources the extended emission was modelled as a function of angular distance from the star. For five sources evidence was found for gradual changes in the mass loss rate.

Four AGB stars have submm fluxes in excess by a factor of 3-5 larger compared to what can be explained with one dust shell. Various explanations are discussed: contributions of molecular lines, free-free emission, variability, different dust emissivities at submm wavelengths and the possibility of a second dust shell from a previous mass loss phase or heating of the ISM by the central star. None of these possibilities by themselves can explain the large submm excess. A combination of them may explain the observations but with the present data set it is not possible to chose between the various possibilities.

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Near-infrared spectroscopy of post-AGB stars

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The results of a medium resolution near-infrared spectral survey of 18 post-AGB stars are presented. Most of the stars have near-infrared hydrogen lines in absorption, which is normal for their spectral types. Three stars, HD 101584, HD 179821 and AC Her have the CO first overtone bands in emission; in two of these the emission is variable. It is suggested that the CO emission is the result of post-AGB mass loss. HD 52961 shows the rarely occurring 3.5 μm emission feature and is only the fourth object in which this feature has been detected.

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Nucleosynthesis in AGB stars: Observation of ^{25}Mg and ^{26}Mg in IRC+10216 and possible detection of ^{26}Al

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We report the detection in the circumstellar envelope IRC+10216 of millimeter lines of the rare isotopomers ^{25}MgNC and ^{26}MgNC, as well as of a line at 234433 MHz, which could be the J= 7–6 transition of ^{26}AlF (an alternate, although less likely identification would be the J= 9–8 transition of NaF). The derived ^{24}Mg:^{25}Mg:^{26}Mg isotopic abundance ratios ($78 : 11 \pm 1.5 : 11 \pm 1.5$) are consistent with the solar system values (78.7:10.1:11.2). According to new calculations of evolutionary models of $3\,M_\odot$ and $5\,M_\odot$ AGB stars, these ratios and the previously measured N, O and Si isotopic ratios imply that the central star had an initial mass $3\,M_\odot \leq M_{*,\rm ini} < 5\,M_\odot$ and has already experienced many 3$^{\rm rd}$ dredge-up events. From this, it can be predicted that the ^{26}Al/^{27}Al

isotopic ratio lies between 0.01 and 0.08; in fact, the value derived in the case U234433 arises from ^{26}AlF is ^{26}Al/^{27}Al= 0.04.

The identification of the ^{25}MgNC and ^{26}MgNC lines was made possible by *ab-initio* quantum mechanical calculations of the molecule geometrical structure. It was confirmed through millimeter-wave laboratory measurements. The quantum mechanical calculations are briefly described and the laboratory results presented in some detail. The rotation constants B, D, H and the spin-rotation constant γ of ^{25}MgNC and ^{26}MgNC, and the hyperfine constants b and eqQ of ^{25}MgNC are determined from a fit of laboratory and astronomical data.

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Dissertation Abstracts

Dust Driven Mass Loss from Long Period Variables

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We present models of circumstellar dust shells around asymptotic giant branch stars based on the simultaneous solution of radiation hydrodynamics and the so-called moment-equations describing time-dependent dust formation, growth and evaporation. Both, the mass loss of carbon-rich stars by purely dust driven winds as well as the influence of stellar pulsation (simulated by a piston below the photosphere) on the dust formation and radiative acceleration have been investigated with the help of these models.

The results obtained can be summarized as follows: (i) The well-studied case of purely dust driven stationary winds is reproduced for models with certain stellar parameters using the full, time-dependent code. (ii) The existence of an instability in the purely dust driven outflow due to a dust-induced κ-mechanism is confirmed. For fixed stellar parameters a transition from stationary winds to models with (more or less) periodical formation of dust layers occurs when the parameter $\varepsilon_C/\varepsilon_O$ (carbon/oxygen abundance) exceeds a critical value. (iii) Piston models are compared to calculations of circumstellar dust shells around long period variables in the literature. The global characteristics of our models are largely the same as in other piston models which include a time-dependent description of the dust component. The differences found are attributed to the differences of the input physics, especially the treatment of the radiative transfer and the energy exchange between gas and radiation.

Messages

Les Comptes-Rendus du WORKSHOP "PLANETARY NEBULAE" tenu au Col de Steige du 3 au 5 juin 1994 seront disponibles prochainement. Pour toute information, s'adresser a Agnes Acker acker@cdsxb6.u-strasbg.fr

IAU Symposium 170

CO: Twenty-five Years of Millimeter-wave Spectroscopy

A symposium to celebrate the 25th anniversary of the detection of carbon monoxide.

29 May – 2 June 1995 • Tucson, Arizona USA

Co-Sponsored by:
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Symposium Objective:

Interstellar carbon monoxide (CO) and several other basic molecules were first detected twenty-five years ago with the 36-foot telescope of the National Radio Astronomy Observatory. These discoveries have profoundly influenced our understanding of several diverse yet interrelated fields, including the phases of the interstellar medium, the initial and final phases of stellar evolution, the chemistry of dense and diffuse interstellar matter and the solar system, the structure of the Milky Way galaxy, and the content and structure of other galaxies. These research areas are among the most fundamental in astrophysics, and the spectroscopic information provided by CO and other molecules serves as the primary tool of investigation. New developments in instrumentation will further increase the power and utility of molecular line spectroscopy. The twenty-fifth anniversary of the detection of CO is a timely opportunity to bring researchers in all these areas together to review progress and discuss future directions. The emphasis of the meeting will be on CO and other molecules as tracers and diagnostics: what we have learned from CO and what remains to be learned

General Topics to be Discussed:

- Giant and diffuse molecular clouds
- Star formation: observational data and constraints on theory
- General chemistry of the ISM and star formation
- Evolved stars: mass loss and chemistry
- CO in the submm, UV, and IR
- The Milky Way Galaxy
- Galaxies
- Planets at mm wavelengths
- Future directions

Additional details are available. See the NRAO World Wide Web information pages for occasional updates (Go to http://info.aoc.nrao.edu/ and click for information on the Tucson site.).

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