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From the editors

We wish you a happy new year. Judging from the large number of abstracts received this month, 1998 will be a very productive year.

Thierry Forveille and Claudine Kahane

Abstracts of recently accepted papers

SiO Maser Forest at the Galactic Center

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A moderately deep survey of stellar maser sources toward the Galactic center has been made in the SiO J=1-0 v=1 and v=2 transitions ($\sim$ 43 GHz) with the Nobeyama 45-m telescope of a beam size of about $40''$. At the Galactic center (Sgr A*), 7 (4 new) SiO maser sources were detected in one beam. In order to investigate the spatial distribution of SiO maser sources, we have also observed the offset positions by $\pm$ $40''$ in Galactic longitude from the Galactic center. In total, 7 (4 new) SiO maser sources were detected at the offset positions. Taking into account the shorter integration time at the offset positions, we find that the surface number density of SiO maser sources is nearly constant at the Galactic center. The number density of SiO maser sources is found to be an order of magnitude higher than the density of OH 1612 MHz objects. A radial-velocity gradient in Galactic longitude was not detected. These facts indicate that the SiO maser sources seen toward the Galactic center are mostly associated with the stellar population of a Galactic stellar nuclear disk of more than a few arc minute radius.

Preprints can be obtained by contacting deguchi@nro.nao.ac.jp
or via WWW on http://xxx.lanl.gov/abs/astro-ph/9712101

Model Atmospheres Broad-Band Colors, Bolometric Corrections and Temperature Calibrations for O - M Stars

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Broad band colors and bolometric corrections in the Johnson-Cousins-Glass system (Bessell, 1990; Bessell & Brett, 1988) have been computed from synthetic spectra from new model atmospheres of Kurucz (1995a), Castelli (1997), Plez, Brett & Nordlund (1992), Plez (1995-97), and Brett (1995a,b). These atmospheres are representative of larger grids that are currently being completed. We discuss differences between the different grids and compare theoretical color-temperature relations and the fundamental color temperature relations derived from: (a) the infrared-flux method (IRFM) for A-K stars (Blackwell & Lynas-Gray 1994; Alonso et al. 1996) and M dwarfs (Tsuji et al. 1996a); (b) lunar occultations (Ridgway et al. 1980) and (c) Michelson interferometry (Di Benedetto & Rabbia 1987; Dyck et al. 1996; Perrin et al. 1997) for K-M giants, and (d) eclipsing binaries for M dwarfs. We also compare color - color relations and color - bolometric correction relations and find good agreement except for a few colors. The more realistic fluxes and spectra of the new model grids should enable accurate population synthesis models to be derived and permit the ready calibration of non-standard photometric passbands. As well, the theoretical bolometric corrections and temperature - color relations will permit reliable transformation from observed color magnitude diagrams to theoretical HR diagrams.

Accepted by A&A

Preprints can be obtained by contacting plez@fysik.lu.se
or via WWW on file://ftp.astro.uu.se/pub/articles/atmos/P120 (see description in Readme file in atmos directory)

High resolution spectroscopy of the post-red supergiant IRC +10420. I: The data.

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A high resolution optical spectrum of the post-red supergiant candidate IRC +10420 is presented. The Utrecht Echelle Spectrograph observations, with a total integration time of more than 9 hours provide a spectral coverage from 3850 A to 1 micron, and a spectral resolution of 9 km/s. The spectrum is shown, and an identification list of lines in the spectrum is provided. From a preliminary analysis of the spectrum we find that the spectral type of IRC+10420 has changed from F8I+ in 1973 to mid- to early A type now, confirming the results of Oudmaijer et al (1996), who claimed a change in temperature based on photometric changes. It is shown that most of the emission lines in the spectrum of IRC +10420 are blue-shifted with respect to the systemic velocity traced by circumstellar rotational CO emission, while the (few) absorption lines - with the exception of some high excitation lines - are red-shifted by 25 km/s, which may suggest infall of material onto the star. Finally, it is found that the interstellar extinction towards IRC +10420, as traced by the Diffuse Interstellar Bands is very large, with an inferred E(B-V) of 1.4 +/- 0.5 compared to a total E(B-V) of 2.4.

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Nucleosynthesis in Red Giant Stars

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The production of elements from helium-3 to fluorine in low- and intermediate-mass stars is reviewed and compared to chemical abundances observed at the surface of both red giant branch and asymptotic giant branch stars. It is highlighted that, while the trends predicted by standard models are generally well confirmed, many chemical abundances observed at the surface of red giants require the operation of non-standard mixing in the stellar interior. In addition, chemical abundance predictions from presently available asymptotic giant branch models further suffer from the uncertainties affecting the third dredge-up phenomenon, the source of neutrons and the hot bottom burning process.

Invited review to be published in 'Cosmic Chemical Evolution', IAU Symp. 187

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or via WWW on http://obswww.unige.ch/ mowlavi/publications/publications.html
or via anonnymous ftp on obsftp.unige.ch, *file* /pub/mowlavi/nuclrgb1.ps.gz

The Formation of Double Degenerates and related objects

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I systematically investigate the formation of double degenerates (DDs) via binary interactions. I consider three evolutionary channels for their formation: stable Roche lobe overflow (RLOF) plus common envelope (CE), CE plus CE, exposed core plus CE, and carry out Monte-Carlo simulations. I explore the effects of model parameters, such as tidal-enhancement parameter for stellar wind, mass transfer efficiency for stable RLOF, and CE ejection efficiency on my results. I also explore the effects of various assumptions about age, metallicity, mass-ratio distribution and wind velocity.

My results show that the model is successful in the explanation of the formation of DDs. I explain with satisfaction the distributions of masses, mass ratios, orbital periods and birth rate of the observed DDs. The main conclusions are as following. (a) Stable RLOF plus CE and CE plus CE are main evolutionary scenarios leading to the formation of DDs. (b) The Galactic birth rate of DDs is $0.03\mathrm{yr}^{-1}$, and the birth rate of DDs with helium (He) white dwarfs (WDs) as brighter components is $0.017\mathrm{yr}^{-1}$. (c) The number of detectable DDs in our Galaxy is three million, and DDs with brighter He WDs make up 56 per cent. (d) The distribution of orbital periods for detectable DDs peaks around 6 hr. (e) WD 0957-666 and WD 1101+364 are formed through stable RLOF plus CE scenario, and WD 0135-052 are possibly carbon-oxygen (CO) WD pair rather than helium (He) WD pair. (f) The Galactic birth rates of close WD binaries and DD mergers are 0.074 and $0.029\ \mathrm{yr}^{-1}$, respectively. (g) The mergers of two He WDs and the mergers of He and CO WDs have masses of $0.61 \pm 0.09 M_{\odot}$ and $0.96 \pm 0.13 M_{\odot}$, respectively. (h) Mass transfer during stable RLOF is not conservative. (i) A tidally enhanced stellar wind exists.

I also investigate the formation of Type Ia supernovae (SNe Ia), cataclysmic variables (CVs), subdwarf O-type (sdO) stars, R Coronae Borealis (R CrB) stars. The birth rates of SNe Ia and CVs are successfully explained in the above model. The model also shows that CVs with longer orbital periods tends to have CO WDs. The birth rates of the mergers of two He WDs (sdO stars) and the mergers of He and CO WDs (R CrB stars) are 0.006 and $0.018\mathrm{yr}^{-1}$ in the Galaxy, respectively. The birth rates of CVs, DDs, DD mergers and SNe Ia are more sensitive to the more recent stellar formation history.

Accepted by M.N.R.A.S.

Preprints can be obtained by contacting han@cfa.ustc.edu.cn

A cold detached dust envelope around an oxygen-rich Mira-type AGB star R Hydrae

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The circumstellar structure of R Hydrae has been investigated in the IRAS survey scan data. R Hya is a late M-type Mira variable star whose IRAS LRS spectrum is classified as 15 (no feature). But, it shows a remarkable infrared excess in the IRAS photometric data, which cannot be explained by an oxygen-rich circumstellar dust envelope of a mass losing late-type star without showing a significant 10 μm silicate feature in the LRS spectrum.

An extended emission component around R Hya is clearly found in the 60 and 100 μm images produced by Pyramid Maximum Entropy (PME) image reconstruction techniques. It is also visible in the individual IRAS scan data at 25, 60 and 100 μm. It firmly indicates the existence of an extended circumstellar dust envelope around R Hya. The IRAS data further suggest the dust envelope being detached from the central star. The detached circumstellar dust envelope is consistent with both the featureless LRS spectrum and the red colors in the IRAS photometric data. R Hya is likely to be experiencing a cessation of mass loss which has lasted for about one hundred years, and which has made the inner boundary of the dust envelope about sixty stellar radii, far from the region which is warm enough to produce the 10 μm feature.

Accepted by Astronomy and Astrophysics

Preprints can be obtained by contacting osamu@astron.pref.gunma.jp

Infrared Imaging and Spectroscopy of the Helix with ISOCAM[1]

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We report infrared images of the Helix nebula centered at 6.9 μm (LW2 filter) and 15 μm (LW3 filter) obtained with ISOCAM on board the Infrared Space Observatory (ISO). Three fields were also measured using the ISOCAM circular variable filter (CVF). The CVF data show that the 5 to 16.6 μm spectrum is dominated by the pure (v=0–0) rotational lines of molecular hydrogen from the S(7) to the S(2) transitions. The strong S(5) H_2 line accounts for most of the emission detected in the LW2 filter. The only atomic lines detected are: the 12.81 μm [NeII] and 8.99 μm [ArIII] which are weak, and 15.55 μm [NeIII] which is strong and accounts for most of the emission in the LW3 filter. No emission bands or continuum of small dust particles are detected despite the carbon-richness of the Helix nebula.

The H_2 emission traces the individual cometary globules of the molecular envelope of the nebula, whereas the [NeIII] emission is distributed along this envelope towards the inner regions of the ionized cavity. The intensities of H_2 rotational lines are accurately predicted using a rotational temperature of 900±50 K and column densities of $\sim 3 \times 10^{18}\,\mathrm{cm}^{-2}$. The total luminosity in the H_2 lines $\sim 4\,L_\odot$ (6% of the star luminosity) is much higher than predicted for photodissociation regions. The significant absence of mid-infrared dust features indicates that in this evolved planetary nebula, the molecular-sized dust particles might have been destroyed by the exposure to the radiation field from the central hot star.

Accepted by Astrophysical Letters

Preprints can be obtained by contacting cox@ias.fr

Quantitative classification of WC and WO stars

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We present a quantitative classification scheme for carbon and oxygen sequence Wolf-Rayet stars. Our scheme uses new high quality optical AAT and INT observations of 20 stars for which we provide narrow-band photometry and estimates of interstellar reddenings. In increasing order of excitation, our spectral classes range from WC11 to WC4 for Wolf-Rayet stars with a dominant carbon line visual spectrum, and subsequently from WO4 to WO1 for those with predominantly oxygen lines. We refine existing WC and WO schemes (Smith et al. 1990; Kingsburgh et al. 1995) to incorporate stars with higher and lower excitation spectral features. Both massive stars and central stars of Planetary Nebulae (CSPNe) can be classified with the unified system. We have found no criterion that cleanly separates spectra of the two types of star, including elemental abundances (C/O or C/He). However, CSPNe show a wider range of line strength and width than massive stars in the same ionization subclass. Systematically lower FWHM(C IV λ5808) are observed in WO-type CSPNe than the massive WO stars.

For WC4–11 stars, our primary diagnostic is the equivalent width or line flux ratio C IV λ5801-12/C III λ5696. We extend the use of this as the principal criterion throughout the WC sequence, with few re-classifications necessary relative to Smith et al. For WO stars, C III is absent and our new criteria, using primarily oxygen lines, take over smoothly. We define subclasses WO4–1, using O VI λ3811-34/O V λ5590 as our primary diagnostic. The continuation in spectral sequence from WC to WO is used to indicate that the sequence is due primarily to excitation effects, rather than significant abundance differences.

Our scheme allows us to confirm that massive stars and CSPNe are differently distributed over the subclasses. Around 3/5 of massive WC stars lie within the range WC5–8, while $\leq$1/5 of CSPNe are found within these spectral types. Stars within both the highest (WO1) and lowest excitation (WC10–11) spectral classes are unique to CSPNe. A WC classification for the hot R CrB star V348 Sgr is excluded (previously [WC12]) since both C III λ5696 and C IV λ5808 are absent in its optical spectrum. Additional criteria allow us to distinguish between WC-type, 'weak emission line' CSPNe, and O stars, allowing us to reclassify the central star of IRAS 21282+5050 (previously [WC11]) as an O star.

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or via WWW on http://www.star.ucl.ac.uk/~pac/publications.html
or via anonymous ftp on ftp.star.ucl.ac.uk/pub/pac/wc.ps.gz

"Real-Time" Evolution in Mira Variables

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After a brief review of our current understanding of Miras and their evolutionary status, three aspects of "real-time" evolution in these and related stars are examined:

- Chemical changes (O-rich to C-rich) due to third dredge-up
- Period changes due to the effects of the helium-shell flash
- The existence of "fossil" dust and gas shells.

Studies of resolved gas and dust shells are highlighted as particularly interesting. They will enable us to examine the mass-loss histories of many late-type stars over the last ten thousand years or so. Such observations have only recently become technically feasible and they are expected to provide important new insights into the late

stages of stellar evolution.

Invited Review for JD8 at IAU General Assembly, to appear in: "Stellar Evolution on Human Time Scale" Eds. Guinan & Koch, New Astronomy Reviews,

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or via WWW on http://xxx.lanl.gov/abs/astro-ph/9801002

Near-infrared photometry and optical spectroscopy of IRAS sources in the Small Magellanic Cloud

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Near-infrared photometry is obtained of 30 IRAS sources in the direction of the Small Magellanic Cloud selected to be possible AGB stars. Low resolution 4000 to 10 000 Å spectroscopy is presented for 10 of them, plus two AGB stars in the LMC. Improved IRAS fluxes are obtained using the GIPSY package.

Based on the optical spectra and analyses of colour-colour diagrams 9 are confirmed or likely carbon stars, and 8 are confirmed or likely oxygen-rich AGB stars. In three cases no near-infrared counterpart could be identified. The remaining 10 objects have the colours of mass-losing AGB stars, but not enough information is available to comment on the chemical type. In two of these cases there is a mismatch between the near-infrared and IRAS colours possibly indicating unusually large variability, or misidentification of the IRAS sources.

Accepted by A&A

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

Spectral features of presolar diamonds in the laboratory and in carbon star atmospheres

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Laboratory analyses on fine-grained diamond residues from primitive meteorites have shown that nano-diamonds represent the most abundant form of presolar dust preserved in meteoritic samples. The presolar diamonds carry isotopic anomalies which indicate a very complex formation history. Several groups of diamonds may exist with origin in different types of stars. In order to identify the sites of formation observationally, we have extracted presolar diamonds from the Allende meteorite and measured the monochromatic absorption coefficient in a form which is useful for stellar atmosphere calculations. The monochromatic absorption coefficient was measured in the wavelength ranges 400–4000 cm^{-1} (2.5–25 μm) and 12200–52600 cm^{-1} (190–820 nm). We have made identical laboratory measurements on CVD diamonds as on the meteoritic diamonds, in order to get a more solid basis for the interpretation of the diamond spectrum. The monochromatic absorption coefficient for the presolar diamonds was incorporated in self-consistent carbon star photospheric models. The main influence of

the diamond dust in our photospheric models is a heating of the upper photospheric layers and a reduction of the C_2H_2 abundance. Due to the relatively small absorption coefficient of the diamonds compared to other stellar dust grains, their spectral appearance is weak. However, the weak interaction of the diamonds with the radiation field may give them an important role in the dust nucleation process. The gas pressure will stay high and the gas will be much closer to hydrostatic equilibrium during possible diamond nucleation than is normally the case in dust forming stellar regions, and therefore allow ample time for the nucleation process.

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Preprints can be obtained by contacting anja@astro.ku.dk
or via WWW on http://www.astro.ku.dk/ anja or at http://babbage.sissa.it Astrophysics,// abstract astro-ph/9712118

Abundance similarities between the R CrB star V854 Cen and the born-again Sakurai's object

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The elemental abundances of the mildly hydrogen-deficient R Coronae Borealis (R CrB) star V854 Cen have been estimated. The R CrB stars have been divided into majority and minority classes judging by their abundance patterns. Class assignment was unambiguous. V854 Cen, however, has traits of both the minority and majority class. Neither V854 Cen nor the three obvious minority members show any clear abundance signatures of having been affected by e.g. dust-gas separation as often observed in post-AGB stars. By chemical composition, V854 Cen closely resembles Sakurai's object, which has probably recently experienced a final He-shell flash. Therefore V854 Cen and Sakurai's object may share the same evolutionary background, which would add support for the final-flash scenario as a viable origin of the R CrB stars. Most of the few differences in abundance ratios between the stars could if so be attributed to milder H-ingestion in connection with the final He-shell flash of V854 Cen. The identification of either the majority or the minority group, if any, as final flash objects, remain uncertain, however, due to the unclear membership status of V854 Cen.

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Observational discovery of the AGB–bump in densely populated color-magnitude diagrams of galaxies and star clusters.

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The huge photometric databases that are being created for stars in the Magellanic Clouds and in Local Group galaxies not only allow detailed study of the star formation history of these systems, but also provide important information on stellar evolutionary theory. Two low-level features above the red-clump in the LMC color-magnitude diagram (CMD) have been discussed by Zaritsky & Lin (1997) and Alcock et al. (1997) as the possible signature of an intervening population. I conclude that one of the features, which has also been associated with the red giant branch bump (RGB–bump) predicted by theory and observed in globular clusters, is instead produced during asymtotic giant branch (AGB) evolution. I will call it the AGB–bump. In this paper, it will be shown that the stellar evolution predictions about the position and strength of the AGB–bump

are in very good agreement with the observed structures in the LMC, M31 and globular clusters. The position in the CMD of the other feature is consistent with the location of the blue-loops of a few Myr old stars and it has also been observed in the CMD of other galaxies with a young stellar population.

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or via WWW on http://xxx.lanl.gov/find/astro-ph/1/AGB-bump/0/1/0/past/1/0

Photospheric composition of the carbon-rich 21 μm post-AGB stars IRAS 22223+4327 and IRAS 04296+3429

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We present a detailed chemical analysis on the basis of high-resolution, high signal-to-noise optical spectra of two post-AGB objects IRAS 22223+4327 and IRAS 04296+3429. Both display the unidentified 21μm feature in their IR-spectra. The analysis is performed using HR 1865 (F0Ib) and HR 1017 (F5Iab) as reference stars. The spectroscopic indicators provide accurate atmospheric parameters of $T_{\rm eff}$=6500 K, $\log g$=1.0 and ξ_t=5.5 km s^{-1} for IRAS 2223+4327 and $T_{\rm eff}$=7000 K, $\log g$=1.0 and ξ_t=4.0km s^{-1} for IRAS 04296+3429. Our high-resolution data are inconsistent with the significantly lower temperatures deduced from spectral-type determinations in the literature based on low resolution spectra and highlight the need of high-resolution spectroscopy for the determination of accurate fundamental parameters of chemically peculiar supergiants.
Both photospheres are found to be metal-deficient with [Fe/H]=$-$0.4 and $-$0.7 respectively. C and N are found to be overabundant. Useful O-lines were only detected in the brighter IRAS 2223+4327 and the O abundance is found to follow the Fe deficiency : the C/O photospheric abundance is about 1.3, but due to the lack of oxygen lines it is difficult to determine accurately. This corroborates the fact that the carriers of the 21μm feature are formed in a carbon rich circumstellar chemistry. Moreover, these IRAS-stars have large overabundances of s-process-elements. The mean abundance of all the measured s-process-elements is [s/Fe]=+1.0 for IRAS 2223+4327 and +1.4 for IRAS 04296+3429. The distribution of the s-process elements can best be described as due to a distribution of neutron exposures with a low mean neutron exposure of τ_0 = 0.2 mbarn^{-1}.
The 21 μm stars form an interesting sub-group in the total post-AGB sample of stars, not only for their IR characteristics, but also in a broader context of stellar (chemical) evolution theory. They show, in contrast to other post-AGB stars, that the 3rd dredge-up has been efficient during their AGB evolution. The mean neutron exposure is lower than expected for their metallicity.
The spectroscopic parameters found for the massive spectral analogues ($T_{\rm eff}$=7500 K, $\log g$=2.0 and ξ_t=3.0 km s^{-1} for HR 1865 and $T_{\rm eff}$=6500 K, $\log g$=2.0 and ξ_t=3.5 km s^{-1} for HR 1017) agree well with the values found in the literature. Both stars display an enrichment in Na, which is commonly observed in massive supergiants but theoretically not well understood.

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Preprints can be obtained by contacting Hans.VanWinckel@ster.kuleuven.ac.be
or via WWW on http://www.ster.kuleuven.ac.be/homepage/publications.html

Maser mapping of dust-driven winds from red supergiants

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High resolution MERLIN maps of water masers at 22 GHz and OH masers in the circumstellar envelopes of envelopes of red supergiants stars reveal complex velocity gradients. The water masers appear to emanate from dense clouds 15 to 20 AU in dimameter which are being accelerated away from the star. OH masers are mostly seen in regions of more gently increasing velocity which are likely to be less dense. Outside the dust formation zone, the stellar wind is driven by radiation pressure on grains. The acceleration continues out to a thousand or more AU from the star in all four supergiants studied. The only mechanism that appears to be able to explain this as a general phenomenon is an increase in the absorption efficiency of the grains. Using the method of Chapman, it is found that at about 100 AU from the star, near the inner edge of the water maser shell, the dust absorption efficiency is $\kappa_{\rm D} \sim 0.2$ m^2 kg^{-1}. $\kappa_{\rm D}$ increases with distance from the star, rising to ≥ 1 m^2 kg^{-1} (similar to the conventional value for astronomical silicates) in thick circumstellar envelopes reaching high terminal velocities. The low values found nearer the star suggest that initially the dust grains are crystalline or have a composition high in metal oxides which renders them more transparent to the stellar IR radiation. Even after growth is complete, the surface composition of the grains must undergo physical or chemical changes to explain the observed circumstellar velocity fields. Dust formation, and the influence of the stellar magnetic field on the grains, is also implicated in producing the the small scale clumpiness and large scale axisymmetries which are seen in circumstellar envelopes.

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MERLIN observations of water maser proper moti ons in VY Canis Majoris.

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MERLIN observations of the 22-GHz water masers in the circumstellar envelope of the supergiant VY CMa show an ellipsoidal distribution with the maximum extent of 700 mas E-W and 400 mas N-S. Comparison features have survived and show proper motions throughout the region. The mean change in position is 28 mas and the proper motions are generally directed away from the assumed stellar position, and tend to be larger for features at greater projected distances. If the H_2O maser region is modelled as a partially filled thick spherical shell, and VY CMa is at a distance of 1.5 kpc then the proper motion velocities in the direction of expansion are between 8 km s^{-1} at a distance of 75 mas from the assumed stellar position, and 32 km s^{-1} at 360 mas. These velocities are consistent with the H_2O maser spectral line velocities which correspond to a maximum expansion velocity of 36 km s^{-1} at 400 mas from the assumed stellar position. These observations are consistent with radiation pressure on dust providing the force to accelerate the stellar wind as it passes through the H_2O maser shell. The H_2O maser region is elongated in the same direction as the dusty nebula around VY CMa. The water masers illuminate the small scale dynamics and clumpiness which show the rôle of dust in driving the outflow. The overall ellipsoidal shape may be due to dust properties such as its behaviour in the stellar magnetic field or to interaction between the wind and circumstellar material. Maser monitoring also shows the difference between changes on the timescale of stellar variability (a few years) and possible stages in the evolution of VY CMa to its likely fate as a supernova.

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High Resolution CO Imaging of the Molecular Disk around the Jets in KjPn 8

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We report high resolution (2.5") CO J=1−0 line imaging which confirms the presence of a molecular disk around the origin of the spectacular, 14' × 4', episodic jets in the planetary nebula KjPn 8. The disk is 30" in diameter with an expansion velocity of ≈ 7 km s^{-1}. The axis of the disk is aligned with the youngest and fastest (≈ 300 km s^{-1}) of the bipolar jets, and there is evidence for interaction between the jets and the disk material. The inner 4" of the disk are photo-ionized by the central star. The disk-jet system dominates the environment of this young nebula, and should govern the morphology of KjPn 8 as it evolves to become fully ionized.

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Dissertation abstracts

Silicate Feature Variation in Long Period Variable Stars

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Thesis work conducted at: University of Denver, Denver, CO, USA

Ph.D dissertation directed by: Robert E. Stencel

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Silicate dust, found around oxygen-rich stars, produces a hallmark mid-infrared spectral feature resulting from the bend or stretch of bonds in the SiO_4 tetrahedron. Long Period Variable (LPV) stars on the Asymptotic Giant Branch produce copious quantities of silicate dust over this short stage of their stellar evolution. A study of 31 oxygen-rich LPVs was conducted over a sixteen month period using the University of Denver's TNTCAM. The study has been supplemented with spectral data from UKIRT CGS3 service observations and IRAS LRS archives. Observations of the silicate features in the circumstellar environment indicate a possible evolutionary sequence for the stars, inferred from the changes of the dust spectra. These new observations suggest a relationship between the dust spectral signature and the stage of the dust formation process. There is evidence that acoustic shocks from the LPV are a catalyst in the dust formation process. Follow on work is already occurring in the form of ISO SWS data on a selected subgroup of LPVs.

To enhance this study, a mid-infrared, cross-dispersed spectrometer, TGIRS, was built. TGIRS covers a wavelength range of 7 to 14 microns at a resolving power of 750. The instrument utilizes a Boeing-Rockwell Si:As BIB HFPA as its detector. It is cooled using a two-stage Gifford-McMahon cryocooler, eliminating the need for liquid cryogens. All of the optics in the system are aluminum, permitting ambient alignment and focusing with a laser. A description of the design and building phases of TGIRS is presented.

Brief descriptions concerning the evolution of LPVs, theories of dust formation, and the signatures of the silicate dust are given. Data acquisition and reduction are described, including a new method for removing telluric attenuation from the data. Spectral energy distributions are shown, including graphs of the silicate features with respect to stellar phase. Finally, results of the statistical analysis of the sample and conclusions are drawn, including a new scenario for silicate dust growth.

Photo-Ionization Studies of Nebulae

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Thesis work conducted at: The Kapteyn Institute, University of Groningen, The Netherlands

Ph.D dissertation directed by: Stuart R. Pottasch

Ph.D degree awarded: September 1997

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The main goal of this thesis is to make a contribution to the understanding of post-AGB and PN evolution by trying to improve the methods for modeling spectroscopic data. A particular emphasis has been put on the modeling of infrared data from *IRAS* and *ISO*. One of the basic problems in nebular research is that no reliable and accurate methods are available to determine even the basic physical parameters of the nebulae. One can argue that photo-ionization modeling is the most promising approach to improve on this situation. Therefore we have constructed a new method to determine the physical parameters of PN using the photo-ionization code *CLD* written by Gary J. Ferland. This photo-ionization code was chosen because it is widely used and has been tested for many different physical conditions. To make the code more suitable for our purposes, including the modeling of *ISO* spectra, an extensive amount of new code was added. However, before this method can be applied, it is necessary to investigate the accuracy of the parameters derived with this method. Only then can one make a well-founded comparison with theoretical predictions. This is a problem which is still widely underestimated and deserves more attention. A first attempt to ascertain the accuracy of the physical parameters is discussed in this thesis.

In the course of this work it was found that a precise value for the angular diameter of the nebula is important for accurately determining physical parameters. The diameter is often determined using a technique called 'gaussian deconvolution'. It was found that this method was only weakly founded in theory. Therefore a theoretical investigation was conducted to determine accurate conversion factors for a variety of surface brightness distributions.

The method for modeling nebulae has been applied several times. First, the method was used to model the LMC PN SMP 58. In this research we could tentatively conclude that the nebulae around LMC [WR] central stars are more compact than their galactic counterparts, illustrating how modeling can give clues on the shaping of nebulae.

Second, the method has been used to model the *ISO SWS* spectra of NGC 7027 and NGC 6543. The *SWS* spectrum of NGC 7027 shows evidence for evolution, or at least variability, of the central star. The preliminary model is not successful in giving a full explanation of the observed changes in the spectrum, based on the assumption that they are only caused by an increase in the stellar temperature. Nevertheless, one can state that models of this type are needed to gain an understanding of the change in the physical conditions occuring in the central star. When this final analysis is combined with an interpretation of the reported decline of the radio flux, this could result in a unique measurement of the evolutionary speed of the central star of NGC 7027. Using the model of NGC 6543, a rather stringent upper limit could be placed on the Lyman continuum emanating from the central star. This is one of the first times that such a constraint could be derived for a stellar spectrum.

CLD has also been used to conduct a parameter study of the spectral evolution of a typical post-AGB star,

with particular emphasis on the evolution of the infrared colors. Several assumptions have to be made in order to calculate evolutionary tracks for post-AGB stars. A study of the type presented here is important for understanding how these assumptions affect the infrared spectrum of the post-AGB stars. The results of this study may be helpful for understanding the observations made in e.g. the *IRAS* color-color diagram. This in turn may lead to an improved understanding of mass loss processes, hydrodynamic interactions and evolutionary rates of the central star. Eventually it may lead to better evolutionary calculations. However, we are still far from this goal and our study should only be viewed as a small step towards achieving this goal. Another benefit from this study is that it may help in identifying more efficient search criteria for post-AGB stars and young PN.

An electronic version of this thesis can be found on my home page: http://www.pa.uky.edu/~peter.
You can also request a printed version by sending me an e-mail.

Stellar structure and dynamics of the inner Galaxy

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Thesis work conducted at: Sterrewacht Leiden, University of Leiden, NL

Ph.D dissertation directed by: Harm Habing

Ph.D degree awarded: 12 1997

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We conducted a systematic survey in the OH 1612–MHz line of the region $-45° < \ell < 10°$ and $|b| < 3°$ with the Australia Telescope Compact Array. The data were searched for spectral–line point sources with a CLEAN algorithm that was developed for this survey. The resulting sample consists of 507 objects, of which OH/IR stars are the majority. The positions are accurate to within $0\farcs5$ and the line–of–sight velocities to within 1 $\mathrm{km\,s^{-1}}$. The stars are good tracers of the potential of the Galaxy and representative of the total stellar content. We used the sample to analyse and model galactic structure and dynamics. We optimized the four scale parameters of a triaxial N–body model to fit the data. The best–fit viewing angle is 25° when only the positional information is used, but increases to 45° when the stellar velocities are included. As the latter fit is the most significant, the probability that the observed micro–lensing optical depth toward Baade's window is produced by a nearly–end–on bar is small. We also find that the bar weakens rapidly with increasing latitude. With a Schwarzschild–type method we constructed analytic, axisymmetric dynamical distribution functions (DFs) for the sample. The two–integral DF fails to reproduce signatures of the line–of–sight–velocity profiles that are typical for barred spiral galaxies. A preliminary three–integral DF reproduces those features very well. All disk asymptotic–giant–branch stars, oxygen–rich as well as carbon–rich, derive from one dynamical population; the differences in their distributions are the result of secular heating and a metallicity gradient. The youngest OH/IR stars still trace the gas and thus spiral waves and resonant rings. We analysed several observed features and argue that the 3–kpc arm is part of an inner ring such as seen in many barred galaxies; those fill the region roughly between the inner ultra–harmonic resonance and the corotation resonance. There is evidence for bar–driven inflow of gas to the galactic Centre and subsequent starbursts, amongst others from a dynamically distinct group of OH/IR stars in the inner 100 pc. We discuss the possibility that an inner–Lindblad resonance has formed recently ($\sim$ 1 Gyr ago) and speculate on the consequences this would have for the further evolution of the bar.

Jobs

L'Université de Lausanne ouvre l'inscription d'un poste de **professeur ordinaire en Astronomie et Astrophysique** auprès de l'Institut d'astronomie de la Faculté des Sciences.

Les candidats et les candidates

- feront preuve d'une grande expérience de la spectroscopie stellaire galactique et extragalactique, seront en mesure de developper, dans ce domaine, un programme d'observation dans le cadre d'organismes internationaux et seront également au bénéfice d'une expérience sérieuse de la modélisation des atmosphères stellaires.
- assumeront un enseignement de base dispensé en francais et participeront à l'enseignement doctoral.

La pourvue de ce poste est conditionnée par l'acceptation d'un financement temporaire par le FNRS. Sous la réserve ci-dessus, l'entrée en fonction interviendra à partir du 1.9.1998.

La candidature d'un ancien collaborateur de l'Institut est annoncée.

Les dossiers comportant curriculum vitae, liste des publications, extrait des cinq publications jugées les plus importantes, bref exposé des intentions de recherche, sont à deposer jusqu'au 15.1.1998 aupres de

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