THE AGB NEWSLETTER

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

No. 32 — 01 December 1996

Editors: Thierry Forveille and Claudine Kahane (agbnews@gag.observ-gr.fr)

Abstracts of recently accepted papers

Superwind Models for the Dust Shells around OH/IR Stars

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We have modeled the dust envelopes around OH/IR stars with the changes in the dust density distribution that are expected from a superwind phase. We explore the effect of a superwind due to a helium shell flash by adding a density enhanced region which proceeds outward. Depending on the position and the degree of the enhancement, the emergent model spectral energy distributions can be significantly different from the ones with the conventional power law density distributions. The time evolution of the spectral energy distribution of a superwind can, at certain times, explain some observations of OH/IR stars. However, at other times in the evolution of a superwind, spectral energy distributions and optical depths that are not observed often result.

Accepted by Astrophysical Journal *Preprints can be obtained by contacting* kwsuh@cbucc.chungbuk.ac.kr

Post-AGB Stars as Standard Extragalactic Candles

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Stars evolving off the asymptotic giant branch and passing through spectral types F and A are excellent candidates for a new extragalactic standard candle. These post-AGB (PAGB) stars are the visually brightest members of Population II systems. They should have a narrow luminosity function, bounded from above by the shorter transition times of more massive and more luminous remnants, and from below by the core mass corresponding to the lowest-mass stars that are leaving the main sequence.

Moreover, PAGB A-F supergiants are easily recognized because of their enormous Balmer jumps, and should lie both in ellipticals and the halos of spirals. I describe a photometric system that combines the Gunn u filter (lying below the Balmer jump) with the standard Johnson-Kron-Cousins BVI bandpasses, and report a successful search for PAGB stars in the halo of M31 using this $uBVI$ system.

The zero-point calibration will come from PAGB A and F stars in Galactic globular clusters. Four are presently known, and have a mean $M_V = -3.4$ with a scatter of only 0.2 mag. Two are in the same cluster, NGC 5986, and their V magnitudes differ by only 0.09 mag, strongly suggesting a narrow luminosity function. Adopting this M_V and calculating the M31 distance from its halo PAGB stars, we exactly reproduce the accepted value.

Future plans include a $uBVI$ survey of all Milky Way globular clusters for PAGB stars in order to strengthen the zero-point calibration, and a survey of Local Group galaxies to check the calibration. Ultimately we believe

we can reach the Virgo Cluster through a distance ladder with only three rungs: subdwarf parallaxes, Milky Way globular clusters, and then directly to Virgo (with *HST*).

Invited paper to appear in proceedings of the STScI May 1996 Workshop on the Extragalactic Distance Scale *Preprints can be obtained by contacting* bond@stsci.edu

Asymmetries around Luminous Red Variables

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Departures from spherical symmetry are known to exist around Luminous Red Variables (LRVs). One of the earliest pieces of evidence came from the discovery that light from these objects is polarized. Additional evidence comes from other techniques and observations of related objects. This talk briefly reviews these data and focus on the mechanisms that produce polarization in LRVs. Emphasis is given on recent spectropolarimetric monitoring data of selected key objects and what we have learned about the LRV environment from such data.

Invited Paper at IAU Symposium no. 177, *The Carbon Star Phenomenom*, ed. Robert Wing (Kluwer) *Preprints can be obtained by contacting* mario@argus.iagusp.usp.br

Mean light curves of long-period variables and discrimination between carbon- and oxygen-rich stars

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Using 75 years of AAVSO data, mean light curve parameters of a sample of 355 long period M, S, and C mira and semi-regular variable stars are investigated. We present a classification of the light curves of LPVs into 6 distinct groups. Combining this classification with IRAS colors makes it possible to distinguish oxygen-rich from carbon-rich miras.

Accepted by Astron. Astrophys. Suppl. *For preprints, contact menes@graal.univ-montp2.fr*

Through the upper AGB towards a planetary: A hydrodynamical simulation

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We present a first exploratory investigation of the dynamical evolution of a dusty stellar wind envelope along the upper AGB and its transformation into a planetary nebula. We find the existence of AGB stars with detached shells to be a natural consequence of the mass loss variations during a thermal pulse. It is also demonstrated that due to the large dynamical effects caused by the ionizing radiation field and the fast wind of the central star, it is impossible to deduce the AGB mass loss history from the planetary's density and velocity distribution. The structure of the halo, however, is still determined by the AGB mass loss history. The rapid decline of mass

loss expected in the aftermath of thermal pulses leads to extended shells of low densities and explains halos with sharp boundaries. The density structure and velocity field of our model planetary closely resemble those of observational counterparts. The possibility of a direct comparison between the hydrodynamical properties of the model and its synthetic emission line spectrum allows a physically consistent interpretation of observed Doppler-split emission lines.

Invited review, to be printed in *Advances in Stellar Evolution*, eds. R.T. Root and A. Renzini, Cambridge University Press.

Preprints can be obtained by contacting deschoenberner@aip.de *or via anonymous ftp on* (141.33.64.1) /pub/steffen/elba/paper/elba.ps.gz. See also the related poster /pub/steffen/elba/poster/SSMS.ps.gz

Infrared Giants vs. Supergiants I. Far infrared-to-CO(1-0) intensity ratio

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Until recently, the correlation between the IRAS flux density at 60 μm, S_{60}, and the intensity of the CO(1–0) line seemed well established for O-rich evolved stars with intermediate mass-loss rates ($\sim$ 10^{-6} to 10^{-5} $M_\odot$/yr). This observational correlation was in agreement with theory of mass-loss rates. On the basis of more sensitive CO(1–0) observations performed with the IRAM-30m antenna, we show that a large group of infrared sources do not follow this correlation. Almost 50% of the infrared O-rich sources in our sample (IRAS flux ratio S_{25}/S_{12} from 0.69 to 1.20) have "weak" CO emission relative to S_{60}. These sources are more concentrated towards the Galactic plane. The majority of them have early spectral types and low IRAS variability index, and are thus probably supergiants, as it is already established for many of them and can be understood from theoretical considerations, mainly related to the large luminosity of the supergiants. We conclude that all those with "normal" CO emission (i.e. a low S_{60}/T_{mb}(1–0) ratio) are AGB stars. Possible origins of the "weak" CO emission observed in a few AGB stars are briefly discussed.

Accepted by Astron. Astrophys. Nov. 1996 *Preprints can be obtained by contacting* josselin@iap.fr

Hot Evolved Objects in Different Parent Galaxies: The Stellar Winds of Three Planetary Nebula Nuclei in the Large Magellanic Cloud

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Three planetary nebulae in the Large Magellanic Cloud were observed with the Faint Object Spectrograph onboard the Hubble Space Telescope. Their central stars display P Cygni-like features in the ultraviolet. We modeled these profiles to derive the stellar wind velocities. The wind velocities of the LMC planetary nebula

nuclei are comparable to those of some Galactic counterparts, but other Galactic objects of similar temparatures exist with higher wind velocities. One object, LMC-SMP 61, has a Wolf-Rayet (WR) type central star. For this nucleus we derived a wind velocity of $-$ 1600 km/s and an upper limit to the mass loss rate of $\dot{M} \leq 7 \times 10^{-7}$ Myr from the He and C lines. The observed continuum emission in the UV and optical range is modeled with a combination of stellar and nebular contributions, yielding independent determinations of stellar and nebular quantities. The sample is numerically too limited for a significant comparison between LMC and Galactic PNNi populations, but represents the first exploration of mass loss properties of *evolved* stellar objects beyond the Milky Way.

Accepted by Astrophysical Journal *Preprints can be obtained by contacting bianchi@stsci.edu*

Structure and Evolution of Central Stars of Planetary Nebulae

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We report on the present status of our knowledge concerning the structure and evolution of central stars of planetary nebulae. It is demonstrated how the whole evolution off the Asymptotic Giant Branch depends on the preceding mass-loss history. Mass loss determines not only the final mass but also the internal structure which controls the detailed evolution into a white dwarf configuration. However, since a theory of mass loss along the AGB is still lacking we have to rely on semi-empirical prescriptions, which do not allow to make precise predictions for the final evolution. In particular, the Wolf-Rayet central stars are still enigmatic objects and constitute a challenge for stellar evolution theory.

Invited review to appear in Astrophysics & Space Science (Proceedings of the RS meeting on PNe, ed. J.E.Dyson & F.D. Kahn) *Preprints can be obtained by contacting bloecker@astrophysik.uni-kiel.de, or via anonymous ftp on 134.245.66.1 in /pub/tbloecker/liverpool.ps.Z*

Semiregular variables of types SRa and SRb. Silicate dust emission features

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We have analysed the IRAS-LRS spectra of representative samples of O-rich Semiregular (SR) variables of types SRa and SRb and of Mira variables. The silicate features were extracted by fitting the energy distribution with two blackbodies, approximating the continuous emission from the photosphere and the circumstellar dust. The shape and strength of the silicate features in the LRS range were then studied by computing the residual fluxes in 5 selected wavelength regions covering the whole 10 μm and 18 μm features and parts of the 10 μm feature assigned to emission from olivine and possibly corundum. We compare our approach with previous investigations and argue that a quantitative study of details in the feature shape requires subtraction of the stellar and the dust continuum and the use of flux ratios rather than a discrete classification system.

The Miras form an extension of the SRb's towards lower stellar temperatures and higher dust shell opacities and they have slightly higher average dust temperatures. The SRa's seem to be more similar to the Miras in their dust shell properties. The average 10 μm feature shapes of the three groups of variables agree, but taking into account the photospheric and dust shell parameters, systematic differences show up. For stars hotter than about 2900 K, the 10 μm feature width shows a wide range of values but no clear trend with the stellar temperature or the optical depth of the dust shell. These stars are generally SRb variables and have the thinnest dust envelopes. At cooler stellar temperatures, where mostly Miras are found, the optical depth of the dust shell determines

the feature width in the sense that thicker shells have narrower features. It appears that the 13 μm feature is obvious only in a narrow range of effective temperature and optical depth of the dust shell.

We discuss our results in terms of radiative transfer effects, differences in the average grain size, annealing and hydration of amorphous silicates and contributions from other dust components. Of these possibilities the last one seems to be most plausible with regard to the behavior of the 10 μm feature width. The observations can be interpreted in terms of changing contributions from olivine and corundum possibly caused by an increasing amount of dust processing (Miras) and the influence of the atmospheric structure on the formation of these dust components (SRb's).

Accepted by Astronomy and Astrophysics *Preprints can be obtained by contacting* hron@astro.ast.univie.ac.at *or via anonymous ftp on* ftp://procyon.ast.univie.ac.at/pub/others/SR_silicate/silicate.ps.Z
or silicate.zip

Barium and Tc-poor S stars: Binary masqueraders among carbon stars

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Our current understanding of the origin of barium and S stars is briefly reviewed by addressing the following questions:
1. Is binarity a necessary condition to produce a barium star?
2. What is the mass transfer mode (wind accretion or RLOF?) responsible for their formation?
3. Do barium stars form as dwarfs or as giants?
4. Do barium stars evolve into Tc-poor S stars?
5. What is the relative frequency of Tc-rich and Tc-poor S stars?

Invited review presented at IAU Symp. 177, *The Carbon Star Phenomenon*, ed. R. Wing *Preprints (paper copy or ps file) can be obtained by contacting* ajorisse@astro.ulb.ac.be

Are symbiotic stars related to barium and extrinsic S stars?

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Symbiotic stars, barium stars and extrinsic (i.e. Tc-poor) S stars are binary systems consisting of a red giant and (for most of them) a white dwarf with orbital periods ranging from hundred to several thousand days. This similarity thus raises the following two questions, that are addressed in this paper: (i) Do some barium or extrinsic S stars exhibit symbiotic activity, and (ii) Do some symbiotic stars exhibit the barium syndrome?

Invited review to appear in *Physical Processes in Symbiotic Binaries and Related Systems*, ed. J. Mikolajewska, Publ. Copernicus Foundation for Polish Astronomy, Warsaw, 1997 *Preprints (paper copy or ps file) can be obtained by contacting* ajorisse@astro.ulb.ac.be

Carbon stars with detached dust shells: the circumstellar envelope of UU Aurigae

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We have modelled the spectral energy distribution of the carbon-rich star UU Aurigae, which shows an excess flux in the far infrared and sub-millimeter regions, in terms of a detached shell generated by an episode of higher (than the current) mass loss rate. Two different compositions for the detached shell were used: oxygen-rich and carbon-rich dust grains. By assuming that at longer wavelengths the extinction coefficients of the oxygen-rich grains follow a λ^{-2} law, and those of the amorphous carbon follow a $\lambda^{-1.3}$ law, we show that the model including a detached carbon-rich shell produces a more satisfactory fit to the observational data compared to the model with a detached oxygen-rich shell. Moreover, we derived a relatively small value for the distance of the detached shell from the central star, which implies that the episode of high mass loss rate ended only few hundred years ago.
The results of our analysis are consistent with the scenario for the stellar evolution on the asymptotic giant branch which predicts a short time-scale modulation of the mass loss rate induced by repeated Helium shell-flashes.

Accepted by A&A *Preprints can be obtained by contacting* sba@star.arm.ac.uk *or via WWW on* http://star.arm.ac.uk/~ambn/preprints.html

Mode switching of the water maser in OH 39.7+1.5

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Monitoring of the H_2O maser in OH 39.7+1.5 as well as spatial interferometry show clear evidence that the maser switches occasionally its beaming direction between radial and tangential paths in step with the stellar pulsation cycle. Outside the minimum, several radially beamed maser features are present, which are absent ($\leq$ 20 mJy) during the minimum. Competition between gain paths causes tangentially beamed maser emission only to occur, when the temperature in the maser shell is too low to excite radially beamed masers.

The radius of the H_2O maser shell extends between 6 10^{14} cm (40 AU) and at least 3 10^{15} cm (200 AU), with the inner radius probably set by quenching of the maser due to high gas density close to the star. Within the H_2O maser shell, the circumstellar outflow accelerates from v$\approx$9 km s^{-1} up to the terminal expansion velocity of $\approx$18 km s^{-1}. The expansion velocity of the circumstellar shell is constant between the outer radius of the water maser shell and the location of the 1612 MHz OH maser shell at 3 10^{16} cm, showing the absence of strong velocity gradients at large radial distances.

Accepted by Astronomy & Astrophysics Main Journal *For preprints, contact http://www.hs.uni-hamburg.de or dengels@hs.uni-hamburg.de*

The spectrum of the cool R Coronae Borealis variable S Apodis in a deep decline

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A high resolution spectrum (5575 - 8875Å) of the cool R Coronae Borealis variable S Apodis in its 1993 deep decline is discussed. Narrow or chromospheric emission lines of Na I, K I, Ca II, and Ba II and broad emission lines of He I 7065Å and Na I D are seen, as expected from published reports of warmer RCBs in decline. The surprise of the S Aps spectrum is the considerable blue blue shift of the broad emission component to the Na D lines. The blue shift may result from lines formed in a bipolar flow which is obscured asymmetrically by soot clouds along the line of sight.

Accepted by PASP *For preprints, contact aruna@iiap.ernet.in*

Dissertation abstracts

Modelling of Circumstellar Environments around Carbon and Oxygen-Rich Stars

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Ph.D dissertation directed by: J.G. Doyle

Ph.D degree awarded: December 1996

In this work we investigate the nature of the dust shells around evolved late-type stars. We solve the problem of the radiative transfer in a spherically symmetric medium, and we model the observed spectral energy distribution (SED) of a selection of asymptotic giant branch stars.

We studied in detail the diagnostic content of the spectral analysis, and developed an algorithm for finding the best-fit to the observational data. We gathered from the literature the extinction coefficients for a large sample of materials prepared as laboratory analogues of the circumstellar dust grains. We observed a selection of carbon and oxygen-rich stars, taking broadband photometry in the optical, near-IR and sub-millimetre, and low-resolution spectra in the mid-IR. We analysed the observed SEDs, paying particular attention to the following problems.

1) Although it is widely accepted that the dust grains in the circumstellar environments of oxygen-rich stars are of silicate, the precise nature of such "astronomical silicate grains" is still far from clear. Recently, several kinds of magnesium-iron silicates have been studied in the laboratory, providing an excellent opportunity to have a deeper insight on the nature of the oxygen-rich cosmic dust grains.

2) Silicon carbide is the main component of the dust shells around carbon stars. However, a large number of carbon stars display unidentified features that have not been reproduced yet by modelling techniques. The recent studies of dust grains of astrophysical interest help us to investigate the origin of such features in more detail than it was possible in the previous years.

3) Many carbon stars with optically thin envelopes show a large far-infrared flux excess, usually ascribed to the presence of a cool detached dust shell. The nature of these detached shells is a controversial matter. It has been suggested that either they are a remnant of the star's former O-rich phase, or they have been produced during a (recent) past episode of higher (than the current) mass loss rate, when the star was already carbon-rich.

In agreement with previous results, we found that, in the circumstellar environments of oxygen-rich stars, silicate grains with olivine stoichiometry are more likely to be present than those with pyroxene stoichiometry, which, instead, might be responsible for some of the unknown features observed in the mid-IR spectra of carbon stars. Small percentages of carbon-rich grains in the circumstellar environments of oxygen-rich stars are not excluded.

Several causes can be invoked to explain the large flux observed at longer wavelengths in carbon stars. In this sense, the problem of the far-IR flux excess of carbon stars has not a unique solution. If the large flux observed at longer wavelengths is produced by phenomena of non-constant mass loss, the derived time scale for such phenomena is of $10^3 - 10^4$ years.

News Jobs

POSTDOCTORAL POSITIONS INSTITUTO DE ASTRONOMIA, UNIVERSIDAD NACIONAL AUTONOMA DE MEXICO.

Applications are invited for several postdoctoral positions at the Instituto de Astronomia at the Universidad Nacional Autonoma de Mexico (UNAM), in Mexico City, with branches in Ensenada, Baja California and Morelia, Michoacan.

Positions are available in theory and observation with emphasis on the following research areas and places: Star Formation (Morelia), Galactic and Extragalactic Dynamics (Ensenada), IR Studies of Galaxies, Blue Galaxies and Extragalactic HII Regions, Interacting Pairs of Galaxies, Induced Starbursts and Active Galactic Nuclei, Ionized Gas in Elliptical and Lenticular Galaxies, Chemical Evolution of Galaxies and Physics of Diffuse Nebulae (Mexico City).

Successful applicants will have access to the National Observatory of Mexico in San Pedro Martir, Baja California, with 0.84m, 1.5m and 2.1m telescopes; low and high resolution spectrographs, optical CCD cameras, an IR camera/spectrograph, a mid-IR camera, a Fabry–Perot scanning Interferometer and Stromgren and Johnson photometers. A network of workstations is available with access to a CRAY-Y/MP (Mexico City) and a SG minisupercomputer (Ensenada). Information can be found on the WEB at http://www.astroscu.unam.mx/, or requested from aguilar@bufadora.astrosen.unam.mx

Positions are for 1 year with option of renewal for another. Applicants should send a letter of intention, curriculum vitae, publication list, a statement of research interests and arrange for two letters of recommendation. Materials should be sent by January 15th, 1997 to:

Dr. Luis A. Aguilar
Postoctoral Committee
Instituto de Astronomia/UNAM
P.O. Box 439027
San Ysidro, CA 92143-9027
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Notifications will be made by February 15th, 1997.

UMIST

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Applications are invited for the above tenured post. We are seeking a dynamic person with a strong research record and interests which complement and extend those of the current members of the Astrophysics Group (T J Millar, I Cherchneff and G A Fuller). Current interests of the Group include astrochemistry, late stages of stellar evolution, interstellar and circumstellar matter, and star formation. We are interested particularly in candidates with a background in theoretical, observational and/or instrumental aspects of molecular astrophysics. The appointee will be expected to play a role in the development of astrophysics courses for undergraduates in physics.

It is hoped that the successful candidate can be in post by 1 June 1997 but a slightly later appointment may be possible by mutual agreement. Informal enquiries may be made to Professor T J Millar on 0161-200-3677, or via e-mail (tjm@ast.phy.umist.ac.uk). Details of the Astrophysics Group can be found on our WWW pages at http://saturn.phy.umist.ac.uk:8000/

Commencing salary will be within the Lecturer A or B scales (£15,154 – £26,430 per annum).

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