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Abstracts of recently accepted papers

The effect of temperature fluctuations on the determination of the carbon abundance of planetary nebulae

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By combining the C III $\lambda\lambda$ 1906 + 1909 with the C II λ 4267 line intensities it is possible to determine $T(C^{++})$; this temperature is, in general, considerably smaller than $T(O^{++})$, the temperature derived from the O III λ 4363 to λ 5007 intensity ratio. We study possible causes for this difference. We show that in the presence of spatial temperature fluctuations $T(C^{++}) < T(O^{++})$. We find that the objects with the highest $T(O^{++}) - T(C^{++})$ values are those that show large velocities and complex velocity fields, therefore we suggest that the deposition of mechanical energy by the stellar winds of PNe is the main responsible for the temperature differences. Based on these arguments and the similar $T(C^{++})$, T(Bac) and T(He I) values, obtained for well observed objects, we propose that the $N(C^{++})/N(H^{+})$ and $N(O^{++})/N(H^{+})$ values derived from the ratio of collisionally excited lines to Hβ should be based on $T(C^{++})$ instead of $T(O^{++})$; alternatively the abundance ratios derived from recombination line intensity ratios are almost independent of the adopted temperature and consequently are more reliable.

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Temperature fluctuations and the chemical composition of planetary nebulae of type I

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We present two new methods to determine the electron temperature based on the He I line intensities. The temperatures derived from these methods are considerably smaller than those derived from the [O III] $\lambda\lambda$4363, 5007 line intensities and imply the presence of large spatial temperature fluctuations in PN. Considering the presence of spatial temperature fluctuations we determine the abundance of some of the most important elements in Type I PN. The He^{+}/H^{+} values derived from different He I lines come into agreement without the need of invoking an unknown process depopulating the 2^3S He I level. We find He, C and N overabundances; alternatively we find that the O/H value is similar to that of stars recently formed, moreover we also find that the Ar/O value is similar to that of H II regions of the solar vicinity (Orion and M17), these results imply that there is no evidence in favor of a decrease of the O abundance in the nebular shells due to nuclear reactions in the central stars.

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Mid-infrared Spectroscopy of Carbon-rich Post-AGB Objects and Detection of the PAH Molecule Chrysene

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We present 10 and 20-μm spectroscopic observations of a sample of F- and G-type carbon-rich post-AGB objects, three of which were known to exhibit the unidentified emission feature at 21 μm. We also find the F3I post-AGB object SAO 163075 to exhibit a (weak) 21-μm emission feature. We additionally obtained a 10-μm spectrum of IRAS 05341+0852, which has been reported to have a possible 21-μm emission band in its *IRAS* LRS spectrum, and obtained new 10 and 20-μm spectra of the carbon-rich bipolar post-AGB sources GL 2688 and GL 618, the extreme carbon star GL 3068, and the planetary nebulae IRAS 21282+5050 and He 2-447, in order to study the evolution of C-rich dust from the early post-AGB through to the planetary nebula (PN) phases. The 7.5–13-μm spectra of the 21-μm band objects exhibit broad plateau emission, shortwards of 9 μm and from 10–13 μm, superposed upon which, in addition to the well-known UIR-band at 11.3 μm, are several new features, at 7.9, 8.2, 10.6, 11.5 and 12.2 μm, differing from those observed in standard UIR-band spectra. An excellent match is found between the wavelengths of these new features and those of bands in the spectrum of chrysene ($C_{18}H_{12}$), one of the simplest PAH molecules. The absence of the new features in the spectra of earlier spectral-type post-AGB objects and PN is consistent with the expected complete dehydrogenation of any PAH molecules having less than 20-25 carbon atoms when exposed to the ultraviolet radiation fields of stars with spectral types earlier than F. Chrysene is not responsible for the 21-μm emission bands observed in the spectra of the cool post-AGB objects. Possible identifications for the 21-μm band in terms of highly hydrogenated 2-dimensional PAH molecules or 3-dimensional fulleranes (hydrogenated fullerenes) are discussed. The mid-infrared spectrum of GL 2688 is largely featureless, apart from two broad weak emission features between 9.5–10.5 and 10.5–12.2 μm. The profiles of the broad 10–13-μm absorption features in the spectra of the extreme carbon star GL 3068 and the C-rich bipolar post-AGB object GL 618 are compared. For GL 3068 the profile shape and the wavelength of peak absorption, near 11 μm, are consistent with absorption by silicon carbide particles. However, the absorption observed towards GL 618 is considerably broader and peaks at 12 μm. Its profile is very similar to that of the 10–13-μm emission plateau observed in the spectra of the 21-μm band objects, suggesting that it arises from absorption by a large column of highly-hydrogenated PAH-type species.

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Hubble Space Telescope Observations of Planetary Nebulae in the Magellanic Clouds III: Ultraviolet Spectroscopy Using the Faint Object Spectrograph

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Ultraviolet grating spectra ($\lambda\lambda$1150-2300) of planetary nebulae in the Magellanic Clouds, obtained with the Faint Object Spectrograph (FOS) on the Hubble Space Telescope (HST), are used to identify and measure

nebular emission lines and continua, and in one case to detect the stellar wind of the central star. Eight nebulae are observed in the Large Magellanic Cloud (LMC) and four in the Small Magellanic Cloud (SMC).

The HST observations are normalized to the photometric scale of ground-based, visible-light spectra ($\lambda\lambda$3400-8000) by means of FOS PRISM observations in the $\lambda\lambda$1350-5100 range. There is an unexplained, systematic discrepency between the average PRISM and ground fluxes of $\sim$30%. Observed and dereddened UV emission line intensities with respect to Hβ are tabulated.

The published reddening determinations based on the Balmer decrement are used to deredden the data. In general, the reddening derived from the He II I(1640)/I(4686) emission line ratio does not agree with that derived from the Balmer decrement. This discrepency suggests the two reddening determinations are truly not equal, or that the applied reddening law deviates from the published average LMC or SMC curves. The uncertainty in the relative PRISM to ground calibration also contributes to the discrepency, but is of less importance than the uncertainty associated with the adopted reddening.

The reddening is also determined from the λ2200 interstellar absorption band, assuming the published average Galactic and Magellanic Cloud reddening curves, and is found to agree with the reddening determined from the Balmer decrement, in most cases. Otherwise, the reddening is always determined to be less than the Balmer decrement value. The exception to this rule is SMC-SMP6, which is the most reddened object in the sample.

An alternative calibration for the HST data is achieved by assuming that the reddening derived from the He II I(1640)/I(4686) ratio must equal the reddening derived from the Balmer decrement. However, this procedure can only be applied to seven of the twelve objects in the sample. The alternative UV line intensities are also tabulated.

Spectra of six of the nebulae are compared with archival IUE observations in the $\lambda\lambda$1200-2000 range. There is satisfactory agreement between the FOS and IUE data for line intensites less than $\sim$Hβ. For stronger lines, the FOS appears to overestimate the measured line fluxes by $\sim$30%, which may be due to the uncertainty associated with the PRISM to ground calibration: the effect is not seen in the smaller fluxes because of larger measurement errors. The continuum fluxes agree to within 50%. Color temperatures, derived from the FOS continuum flux ratios, are uncertain by at least a factor of two and are not correlated with previouly determined Zanstra temperatures.

Nebular densities, derived from O IV] and Si III] UV emission line ratios, are presented. They are larger than densities derived from visible light [O II] and [S II] line ratios, consistent with the premise that the higher ionisation species are formed in denser regions, supposedly closer to the central star.

Nebular temperatures are determined using the N^+ [I(2139)+I(2143)]/[I(6548)+I(6583)] ratio and are found to be in agreement with the previously published, solely optical N^+ temperatures, when the PRISM to ground calibration is used. When the N II] fluxes are scaled with respect to the helium lines, the N^+ temperatures reduce to $\sim$11000 K in all instances.

Nebular temperatures implied by the O^{2+} [I(1661)+I(1666)]/I(5007) ratio are consistent with those derived from the I(4363)/I(5007) ratio if the PRISM to ground calibration is used. The high O^{2+} electron temperatures for SMC-SMP28 and LMC-SMP87 imply photoionisation is not the sole excitation process in the O^{2+} zone. However, if the UV line fluxes are rescaled such that the reddening from the Balmer decrement and the He II lines agree, then the optically-derived temperatures for these two objects appear to be overestimated by $\sim$10000 K.

Estimates of the C/O abundance ratio are made for most objects in the sample using the C III] $\lambda\lambda$1907, 1909, O III] $\lambda\lambda$1661, 1666, and [O III] λ5007 emission lines. The C/O ratio is anticorrelated with the previously published N/O values, suggesting that the hot bottom burning process operated during the AGB phase. There are four type I objects in the sample, which have the lowest C/O values. The Si/C ratio is also estimated solely from ultraviolet lines. Silicon emission is only detected in the four type I objects.

P-Cygni type line profiles are detected in the spectrum for LMC-SMP76 at N V $\lambda\lambda$1239, 1243, O V λ1371 Å, and C IV $\lambda\lambda$1548, 1551. The edge velocities derived from these lines are 1000-1500, 800, and 2000 km s^{-1}, respectively.

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Physical conditions in the transition regions around the Ring Nebula and NGC 7027

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Deep long-slit spectra have been obtained in order to map the electron temperture and density in the warm transition regions around the Ring Nebula using the optical [C I] and [N I] forbidden lines. For the first time the [C I] λ8727 line is detected and mapped in this nebula. The temperature-sensitive [C I] nebular to auroral line ratio ($\lambda 9824 + \lambda 9850)/\lambda 8727$, yields a mean electron temperature of 8250 K, while variations of up to 2000 K can be seen for emission from the different parts of the nebula. The electron density derived from the density-sensitive [N I] doublet ratio, $\lambda 5198/\lambda 5200$, is similar to that deduced for the fully ionized regions using the [Cl III] $\lambda 5517/\lambda 5537$ doublet ratio. As compared to lines from ionized regions, the [C I] and [N I] lines show dramatic and complex variations, both in their surface brightness distributions and in their radial velocities along the nebular minor axis, in a manner largely consistent with the bipolar model proposed by Bryce, Balick & Meaburn (1994) for the Ring Nebula. The bulk material movement revealed by the large outflow velocities in the transition regions (up to ± 35 km s^{-1}), relative to the ionized regions, is likely to generate strong shocks, and thus provides a natural excitation mechanism for the strong near infrared H_2 emission lines observed in the Ring Nebula. We have also observed NGC 7027. The new observations confirm the earlier results of Danziger and Goad (1973), who found a very small $(\lambda 9824 + \lambda 9850)/\lambda 8727$ ratio for NGC 7027 and correctly attributed it as due to collisional de-excitation of the upper levels of the [C I] nebular lines under the very high density conditions found in NGC 7027.

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On the evolution of stars which form electron-degenerate cores processed by carbon burning. II. Isotope abundances and thermal pulses in a 10 $M_\odot$ model with an ONe core and applications to Long Period Variables, Classical Novae, and accretion induced collapse.

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A 10 $M_\odot$ model of population I composition is evolved from the hydrogen-burning main-sequence to the thermally pulsing "super" asymptotic giant branch (TPSAGB) stage where it has an oxygen-neon (ONe) core of mass 1.196 $M_\odot$ and is experiencing thermal pulses driven by helium-burning thermonuclear flashes. Interior abundance characteristics are relevant to an understanding of core collapse of massive accreting white dwarfs in close binary star systems. At mass point 0.2 $M_\odot$, abundances by mass are $X(^{16}\mathrm{O}) = 0.656$, $X(^{20}\mathrm{Ne}) = 0.215$, $X(^{23}\mathrm{Na}) = 0.0467$, $X(^{24}\mathrm{Mg}) = 0.0325$, $X(^{25}\mathrm{Mg}) = 0.0115$, $X(^{12}\mathrm{C}) = 0.0112$, $X(^{22}\mathrm{Ne}) = 0.00893$, $X(^{21}\mathrm{Ne}) = 0.00689$, $X(^{26}\mathrm{Mg}) = 0.00560$, and $X(^{27}\mathrm{Al}) = 0.00528$. Abundances near the surface of the core are relevant to an understanding of nova outbursts in cataclysmic variables. At mass point 1.17 $M_\odot$, abundances by mass are $X(^{16}\mathrm{O}) = 0.511$, $X(^{20}\mathrm{Ne}) = 0.313$, $X(^{12}\mathrm{C}) = 0.00916$, $X(^{23}\mathrm{Na}) = 0.0644$, $X(^{24}\mathrm{Mg}) = 0.0548$, $X(^{25}\mathrm{Mg}) = 0.0158$, $X(^{27}\mathrm{Al}) = 0.0108$, $X(^{26}\mathrm{Mg}) = 0.00989$, $X(^{21}\mathrm{Ne}) = 0.00598$, and $X(^{22}\mathrm{Ne}) = 0.00431$. Carbon burning is quenched at the beginning of the thermally pulsing phase and a layer of CO matter of mass ~ 0.015 $M_\odot$ separates the ONe core from overlying helium- and hydrogen-rich layers. The outer 0.01 $M_\odot$ of the CO layer contains essentially no neon: very little new ^{20}Ne has been made, and most of the ^{22}Ne which has been made from the original CNO elements has been converted into ^{25}Mg and neutrons which have been captured to form neutron-rich isotopes. If the observational counterpart of the model is in a close binary and fills its Roche lobe near the end of the carbon-burning phase, and if the binary evolves into a cataclysmic variable, one expects that the ejecta of approximately 1000 nova outbursts will exhibit an underabundance of neon and overabundances of carbon, oxygen, and magnesium.

During the TPSAGB phase, characteristics of a pulse cycle approach local limit-cycle values after about 30 pulses. Helium shell flashes are of about the same strength ($L_{He}^{max} \sim 3 \times 10^6\ L_\odot$, $L_{He}^{min} \sim 100\ L_\odot$) as in AGB models with CO cores of mass $\sim 1\ M_\odot$, but the time between flashes ($\sim$ 200 years) and the mass of helium fuel built up between flashes ($\sim 1.3 \times 10^{-4}\ M_\odot$) are much smaller. The amount of energy released in a flash is not enough to propel matter at the hydrogen-helium discontinuity far enough outward that associated cooling extinguishes hydrogen burning ($L_H^{min} \sim 10^2\ L_\odot$, $L_H^{max} \sim 6 \times 10^4\ L_\odot$). The temperature at the base of the convective shell forced by helium burning attains a maximum of $T_{CSB}^{max} \sim 360 \times 10^6$ K. Depending on the choice of cross section for the ^{22}Ne$(\alpha, \mathrm{n})^{25}$Mg reaction, 50-80% of the ^{22}Ne initially in the convective shell is converted into ^{25}Mg, providing 20-30 neutrons for every ^{56}Fe seed nucleus. The neutron density ($\sim 6 \times 10^{12}$ cm^{-3}) is presumably much larger than appropriate for producing s-process isotopes in the solar system distribution at critical branch points. During pulse powerdown, at least 7% and perhaps as much as 30% of the matter which has been in the convective shell is dredged up into the convective envelope. Thus, an observational counterpart of the model may exhibit an enhancement of heavy s-process isotopes in a non-solar distribution and a distinctly non-solar distribution of Mg isotopes, but because of the large mass of the convective envelope, these anomalies may not be detectable in a typical TPSAGB star. The abundance of Li relative to H in a model may be much larger or much smaller than Li/H $\sim 10^{-10}$, depending on the treatment of convection and on where in the TPSAGB phase the model is. At the beginning of the TPSAGB phase, the surface abundances by number of CNO elements are in the ratio (C: N: O) = (2.4: 4.3: 6.3), compared with the initial ratios (C: N: O) = (3.6: 1.0: 8.0). During the TPSAGB phase, the ratio of C to N decreases and the ratio of ^{12}C to ^{13}C decreases from ~ 25 to ~ 4. A test of these predictions involves abundance estimates of the brightest long period variables in the Galaxy and in the Magellanic Clouds. Perhaps the major signature of a TPSAGB star is a brightness greater than the "classical limit" of $M_{bol} = -7.1$. Betelgeuse in our Galaxy and four stars in the Magellanic Clouds are brighter than the supposed limit, but they exhibit abundance characteristics which can be accounted for in the framework of TPSAGB theory. Assuming that a superwind removes mass from the surface at a rate of $\sim 10^{-4}\ M_\odot$ yr^{-1}, the final mass of the ONe white dwarf formed by our TPSAGB model is $\sim 1.26\ M_\odot$, the outer 0.06 $M_\odot$ of which is composed primarily of carbon and oxygen.

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Obscured AGB stars in the Magellanic Clouds: Near-infrared and mid-infrared counterparts

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We have carried out an infrared search for obscured AGB stars in the Magellanic Clouds. Fields were observed in the vicinity of IRAS sources with colours and flux densities consistent with such a classification. The survey uncovered a number of obscured AGB stars as well as some supergiants with infrared excess. We present photometry of the sources and discuss the colour diagrams and bolometric luminosities. Most of the AGB stars are luminous, often close to the classical limit of $M_{bol} = -7.1$. One of the supergiants is close to the maximum luminosity allowed for red supergiants, implying a progenitor mass around 50 $M_\odot$. Its late spectral type (M7.5) is surprising for such a massive star. To determine whether the stars are oxygen-rich or carbon-rich, we have acquired narrow-band mid-infrared photometry with the ESO TIMMI camera for several sources. All but one are found to show the silicate feature and therefore to have oxygen-rich dust: the colours of the remaining source are consistent with either an oxygen-rich or a carbon-rich nature. A method to distinguish carbon and oxygen stars based on H$-$K versus K$-$[12] colours is presented. We discuss several methods of

calculating the mass-loss rate: for the AGB stars the mass-loss rates vary between approximately 5×10^{-4} and $5 \times 10^{-6}\, M_{\odot}\, yr^{-1}$, depending on assumed dust-to-gas mass ratio. We present a new way to calculate mass-loss rates from the OH-maser emission. We find no evidence for a correlation of the mass-loss rates with luminosity in these obscured stars. Neither do the mass-loss rates for the LMC and SMC stars differ in any clear systematic way from each other. Expansion velocities appear to be slightly lower in the LMC than in the Galaxy. Period determinations are discussed for two sources: the periods are comparable to those of the longer-period galactic OH/IR stars. All of the luminous stars for which periods are available, have significantly higher luminosities than predicted from the period–luminosity relations.

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Far-Infrared Water Line Emissions From Circumstellar Outflows

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We have modeled the far-infrared water line emission expected from circumstellar outflows from oxygen-rich late-type stars, as a function of the mass-loss rate and the terminal outflow velocity. For each mass-loss rate and terminal outflow velocity considered, we computed self-consistently the gas density, temperature, outflow velocity, and water abundance as a function of distance from the star. We then used an escape probability method to solve for the equilibrium level populations of 80 rotational states of water and thereby obtained predictions for the luminosity of a large number of far-infrared rotational transitions of water. In common with previous models, our model predicts that water will be copiously produced in the warm circumstellar gas, and that water rotational emission will dominate the radiative cooling. *However, our use of a realistic radiative cooling function for water leads to a lower gas temperature than that predicted in previous models. Our predictions for the far-infrared water line luminosities are consequently significantly smaller than those obtained in previous studies.* Observations to be carried out by the Infrared Space Observatory will provide a crucial test of the models presented here.

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Messages

ASTRID :
Advanced Stars : a Tool for Relating Informations and Data

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Informations about stars in an advanced evolutionnary stage, peculiarly of red giants, AGB and post-AGB variables, are scattered, so we elaborate a working tool to make easier their use. This data base gathers in a same tool observationnal data with comments and results from modelisations. Our aim is not to produce an exhaustive base but an evolutive one in relation to the needs of users and the large number of new soon coming data (HIPPARCOS, NIR Surveys, ISO...). ASTRID (Advanced Stars: a Tool for Relating Information and Data) is becoming usable. A first model adapted to astronomy is working and first data are being included to the base. We hope to be able to serve soon a first version to the community on a www server.

For receiving further informations about ASTRID, please contact us.