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Abstracts of recently accepted papers

Optical properties of the silicate dust grains in the envelopes around AGB stars

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We have investigated optical properties of the silicate dust grains in the envelopes around oxygen rich AGB stars with close attention to the infrared observations of the stars and the laboratory measured optical data of the candidate dust grain materials. We have compared the radiative transfer model results with the observed spectral energy distributions of the stars including the *IRAS* PSC and *IRAS* LRS data. We find that the opacity function at $\lambda > 13$ μm for the OH/IR stars with thick dust shells is different from the opacity for the stars with thin dust shells. This may be the effect of some changes of optical constants of the dust grains depending on the temperature. From the opacity functions, we derive two sets of optical constants for the warm and cool silicate dust grains. The optical constants satisfy the Kramers-Kronig relation and produce the opacity functions which fit the observations of AGB stars better than previous works. From the opacity functions, we have calculated the Planck mean values of the optical efficiency factors.

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The origin of carbon, investigated by spectral analysis of solar-type stars in the Galactic Disk

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Abundance analysis of carbon has been performed in a sample of 80 late F and early G type dwarf stars in the metallicity range $-1.06 \leq$ [Fe/H] ≤ 0.26 using the forbidden [C I] line at 8727Å. This line is presumably less sensitive to temperature, atmospheric structure and departures from LTE than alternative carbon criteria. We find that [C/Fe] decreases slowly with increasing [Fe/H] with an overall slope of -0.17 ± 0.03. Our results are consistent with carbon enrichment by superwinds of metal-rich massive stars but inconsistent with a main origin of carbon in low-mass stars. This follows in particular from a comparison between the relation of [C/O]

with metallicity for the Galactic stars and the corresponding relation observed for dwarf irregular galaxies. The significance of intermediate-mass stars for the production of carbon in the Galaxy is still somewhat unclear.

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HST-WFPC2/H-alpha Imagery of the Nebula M1-67: A Clumpy LBV Wind Imprinting Itself on the Nebular Structure?

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With the Hubble Space Telescope's Wide Field Planetary Camera 2, we have obtained a deep, H-alpha image of the relatively young ejection-type nebula M1-67 around the runaway population-I Wolf-Rayet star WR124 (WN8). This image shows a wealth of complex detail, some of which have never been seen before in such a nebula. In particular, large arcs of nebulosity extend around the central star yet with no overall global shell structure to the nebula and no clear bipolar signature as claimed by Sirianni et al. (1998). In addition, numerous bright, mostly unresolved knots of emission, each $\lesssim 10^{-4}$ $M_{\odot}$, occur in the inner part of the nebula, often surrounded by what appear to be their own local "wind" diffuse bubbles. Is this the first direct evidence of spatially resolved hot clumps being ejected from a hot central star?

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High quality images are available on
http://www.astro.umontreal.ca/ yves/m1_67.jpg *and* http://www.astro.umontreal.ca/ yves/inner.jpg
A compressed version of the letter is available on http://www.astro.umonttreal.ca/ yves/apjl.ps.gz

The RV Tauri phenomenon and binarity.

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We present accurate radial velocity measurements on the pulsating extremely iron-deficient post-AGB object HD 52961 and the RV Tauri star EN TrA (HD 131356) proving them to be binaries. Our long-term photometric monitoring campaign shows that the RV Tauri photometric class "b" phenomenon in HD 52961 is due to variable circumstellar extinction during orbital motion.

By comparing carefully the observational characteristics of RV Tauri stars and the class of extremely iron-deficient post-AGB objects we conclude that binarity is a widespread phenomenon in the RV Tauri class of objects. The observed chemical depletion patterns, weak circumstellar CO emission, peculiar spectral energy distribution and the difference in photospheric class of the RV Tauri objects can all be naturally explained by assuming that the circumstellar material is not freely expanding, but trapped in the binary system.

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Post-AGB Evolution

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This review focuses on the evolution of single and binary optically bright post-AGB stars and the relation between the photospheric chemical abundances and the circumstellar material.

Surface abundance determinations of optically bright post-AGB stars offer a powerful tool, not only to clarify the evolutionary nature of the objects themselves, but also to constrain theoretical calculations for chemical evolution. However, a survey of recent results shows that the chemical patterns observed are very diverse and that several different classes can be distinguished. The most striking result is that only a minor fraction, namely the 21 μm objects, are conform to standard post third dredge-up theory.

In recent years it became clear that binarity can influence the late evolutionary stages considerably. A second part therefore discusses the varied and fundamental impact of the presence of a companion on the evolution of post-AGB systems.

Invited review presented at IAU Symp. 191 : "AGB Stars" editors: T. Le Bertre, C. Waelkens and A. Lèbre.

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The Accretion of Brown Dwarfs and Planets by Giant Stars – I. AGB Stars

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We study the response of the structure of an asymptotic giant branch (AGB) star to the accretion of a brown dwarf or planet in its interior. In particular, we examine the case in which the brown dwarf spirals-in, and the accreted matter is deposited at the base of the convective envelope and in the thin radiative shell surrounding the hydrogen burning shell. In our spherically symmetric simulations, we explore the effects of different accretion rates and we follow two scenarios in which the amounts of injected mass are equal to ~ 0.01 and $\sim 0.1 M_{\odot}$. The calculations show that for high accretion rates ($\dot{M}_{acc} = 10^{-4} M_{\odot} yr^{-1}$), the considerable release of accretion energy produces a substantial expansion of the star and gives rise to hot bottom burning at the base of the convective envelope. For somewhat lower accretion rates ($\dot{M}_{acc} = 10^{-5} M_{\odot} yr^{-1}$), the accretion luminosity represents only a small fraction of the stellar luminosity, and as a result of the increase in mass (and concomitantly of the gravitational force), the star contracts. Our simulations also indicate that the triggering of thermal pulses is delayed (accelerated) if mass is injected at a slower (faster) rate. We analyze the effects of this accretion process on the surface chemical abundances and show that chemical modifications are mainly the result of deposition of fresh material rather than of active nucleosynthesis. Finally, we suggest that the accretion of brown dwarfs and planets can induce the ejection of shells around giant stars, increase their surface lithium abundance and lead to significant spin-up. The combination of these features is frequently observed among G and K giant stars.

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Infrared Spectra of Meteoritic SiC Grains

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We present here the first infrared spectra of meteoritic SiC grains. The mid-infrared transmission spectra of meteoritic SiC grains isolated from the Murchison meteorite were measured in the wavelength range 2.5–16.5 μm, in order to make available the optical properties of presolar SiC grains. These grains are most likely stellar condensates with an origin predominately in carbon stars. Measurements were performed on two different extractions of presolar SiC from the Murchison meteorite. The two samples show very different spectral appearance due to different grain size distributions. The spectral feature of the smaller meteoritic SiC grains is a relatively broad absorption band found between the longitudinal and transverse lattice vibration modes around 11.3 μm, supporting the current interpretation about the presence of SiC grains in carbon stars. In contrast to this, the spectral feature of the large (> 5 μm) grains has an extinction minimum around 10 μm. The obtained spectra are compared with commercially available SiC grains and the differences are discussed. This comparison shows that the crystal structure (e.g., β-SiC versus α-SiC) of SiC grains plays a minor role on the optical signature of SiC grains compared to e.g. grain size.

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Shaping Bipolar and Elliptical Planetary Nebulae: Effects of Stellar Rotation, Photoionization Heating and Magnetic Fields

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We present 2-dimensional hydrodynamical and magneto-hydrodynamical simulations of the evolution of planetary nebulae formed through the interaction of two succeeding, time-independent stellar winds. Both winds are modeled according to a consistent physical prescription for the latitudal dependence of their properties. We propose that single stars with initial masses above ~ 1.3 $M_{\odot}$can achieve near-critical rotation rates during their "superwind" phase at the tip of the asymptotic giant branch (AGB). We show that the resulting equatorially confined winds and their subsequent inflation to a double lobe structure by the post-AGB wind leads to the typical hourglass shape found in many planetary nebulae, as MyCn18.

Following Chevalier & Luo (1994) and Różyczka & Franco (1996), we then combine the effect of a magnetic field in the post-AGB wind with rotating AGB winds. We obtain highly collimated bipolar nebula shapes, reminiscent of M2-9 or He 2-437.

For sufficiently strong fields, ansae and jets in the polar regions of the nebula are formed, similar to those observed in IC 4593. Weaker fields are found to be able to account for the shapes of classical elliptical nebulae,

e.g. NGC 6905, in the case of spherically symmetric AGB winds, which we propose for single stars with initial masses below $\sim$ 1.3 $M_\odot$.

Photoionization, via instabilities in the ionization-shock front, can generate irregularities in the shape of the simulated nebulae. In particular, it leads to the formation of cometary knots, similar to those seen in the Helix nebula (NGC 7293). This effect may also be responsible for large scale irregularities like those found in Sh 2-71 or WeSb 4.

We arrive at a scenario in which the majority of the planetary nebula with their diverse morphologies is obtained from single stars. This scenario is consistent with the Galactic distribution of the different nebula types, since spherical and elliptical nebulae — which have a distribution with a large scale height above the Galactic plane — are ascribed to progenitor masses below $\sim 1.3M_\odot$, with magnetic effects introducing ellipticities. Bipolar nebulae, on the other hand — which are on average closer to the Galactic plane — are found to stem from progenitors with initial masses above $\sim 1.3M_\odot$.

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Chemical Abundances of Planetary Nebulae in the Bulge and Disk of M31

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We derive abundances and central star parameters for 15 planetary nebulae (PNe) in M31: 12 in the bulge and 3 in a disk field 14 kpc from the nucleus. No single abundance value characterizes the bulge stars: although the median abundances of the sample are similar to those seen for PNe in the LMC, the distribution of abundances is several times broader, spanning over 1 decade. None of the PNe in our sample approach the super metal-rich ([Fe/H] $\sim$ +0.25) expectations for the bulge of M31, although a few PNe in the sample of Stasińska, Richer, & Mc Call (1998) come close. This [O/H] vs [Fe/H] discrepancy is likely due to a combination of factors, including an inability of metal-rich stars to produce bright PNe, a luminosity selection effect, and an abundance gradient in the bulge of M31. We show that PNe that are near the bright limit of the [O III] λ5007 planetary nebula luminosity function (PNLF) span nearly a decade in oxygen abundance, and thus, support the use of the PNLF for deriving distances to galaxies (Jacoby 1996) with differing metallicities. We also identify a correlation between central star mass and PN dust formation that partially alleviates any dependence of the PNLF maximum magnitude on population age. Additionally, we identify a spatially compact group of 5 PNe having unusually high O/H; this subgroup may arise from a recent merger, but velocity information is needed to assess the true nature of the objects.

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Do S Stars show strong Silicate Dust Emission?

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S stars are generally regarded as intermediate between M and carbon stars in their properties, including the composition of their circumstellar material, as befits stars having an intermediate level of C/O enhancement. The existence of several stars with optical S classification but very strong silicate dust emission at 10 μm presents an anomaly. One suggestion was that these stars are intermediate between M stars and the ^{13}C-rich carbon stars with silicate dust emission from circumstellar material. However, new optical spectra show that these stars are either M stars or marginal MS stars, so that silicate dust emission declines along the $M \rightarrow MS \rightarrow S$ sequence and is not present in C stars with the exception of a few J-type silicate-carbon stars.

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