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Abstract of recently accepted papers

The Correlations between Planetary Nebula Morphology and Central Star Evolution. Analysis of the Northern Galactic Sample.

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Northern Galactic Planetary nebulae (PNs) are studied to disclose possible correlations between the morphology of the nebulae and the evolution of the central stars (CSs). To this end, we have built the best database available to date, accounting for homogeneity and completeness. We use updated statistical distances, an updated morphological classification scheme, and we calculate Zanstra temperatures for a large sample of PNs. With our study we confirm that round, elliptical, and bipolar PNs have different spatial distributions within the Galaxy, with average absolute distances to the Galactic plane 0.73, 0.38, and 0.21 kpc respectively. We also find evidence that the distributions of the central star's masses are different across these morphological groups, although we do not find that CSs hosted by bipolar PNs are hotter, on average, than CSs within round and elliptical PNs. Our results are in broad agreement with the previous analyses, indicating that round, elliptical, and bipolar PNs evolve from progenitors in different mass ranges, and may belong to different stellar populations, as also indicated by the helium and nitrogen abundances of PNs of different morphology.

Accepted by the Astrophysical Journal.

Preprints can be obtained by contacting lstanghe@stsci.edu

Also available from the URL http://asXiv.org/abs/astro-ph/0204185

Sakurai's Object (V4334 Sgr): Evolution of the dust shell from 1999 to 2001

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We present fits to $1-5\,\mu$m spectra of the dust shell around Sakurai's Object (V4334 Sgr) obtained over the period May 1999 to September 2001, using the DUSTY modelling program. We find that the emission is consistent with carbon dust grains whose optical properties are predominatly graphitic, and whose sizes range from $\sim 0.005\,\mu$m to $\sim 1-2\,\mu$m with size distribution $n(a)da \propto a^{-3}da$.

We further find an increase in the mass-loss rate, and in the angular diameter of the dust shell, which may now be resolvable in the mid-infrared with 8-10 m class telescopes. We also determine the time-dependence of the stellar luminosity and radius, and find consistency with recent evolutionary modelling.

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Preprints can be obtained by contacting vht@astro.keele.ac.uk

The carrier of the "30" μm emission feature in evolved stars. A simple model using magnesium sulfide.

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We present 2−45 μm spectra of a large sample of carbon-rich evolved stars in order to study the "30" μm feature. We find the "30" μm feature in sources in a wide range of sources: low mass loss carbon stars, extreme carbon-stars, post-AGB objects and planetary nebulae. We extract the profiles from the sources by using a simple systematic approach to model the continuum. We find large variations in the wavelength and width of the extracted profiles of the "30" μm feature. We modelled the whole range of profiles in a simple way by using magnesium sulfide (MgS) dust grains with a MgS grain temperature different from the continuum temperature. The systematic change in peak positions can be explained by cooling of MgS grains as the star evolves off the AGB. In several sources we find that a residual emission excess at $\sim$26 μm can also be fitted using MgS grains but with a different grains shape distribution. The profiles of the "30" μm feature in planetary nebulae are narrower than our simple MgS model predicts. We discuss the possible reasons for this difference. We find a sample of warm carbon-stars with very cold MgS grains. We discuss possible causes for this phenomenon. We find no evidence for rapid destruction of MgS during the planetary nebula phase and conclude that the MgS may survive to be incorporated in the ISM.

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Preprints can be obtained by contacting mailto:hony@astro.uva.nl or via WWW on http://www.astro.uva.nl/ hony/30micron_iso.pdf

The ERE of the "Red Rectangle" revisited

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We present in this paper high signal-to-noise long-slit optical spectra of the Extended Red Emission (ERE) in the "Red Rectangle" (RR) nebula. These spectra, obtained at different positions in the nebula, reveal an extremely complex emission pattern on top of the broad ERE continuum. It is well known that three features converge at large distance from the central object, in wavelength and profile to the diffuse interstellar bands (DIBs) at 5797, 5849.8 and 6614 Å, (e.g. Sarre et al., 1995). In this paper we give a detailed inventory of all spectral subfeatures observed in the 5550–6850 Å spectral range. Thanks to our high S/N spectra, we propose 5 new features in the RR that can be associated with DIBs. For the 5550–6200 Å spectral range our slit position was on top of the NE spike of the X shaped nebula. A detailed description of the spatial profile-changes is given of the strongest features revealing that even far out in the nebula at 24″ from the central star, there remains a small shift in wavelength of 1 respectively 2 Å, between the ERE subfeatures and the DIB wavelengths of 5797.11 and 5849.78 Å.

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On the Death of OH/IR Stars

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Since the net duration of all 1612 MHz emission phases from $|b| > 10°$ OH/IR stars is ∼1700 yr, one "death", as evidenced by the disappearance of all 1612 MHz masers, should occur in a sample of 170 every ten years on average, if they only have one emission phase. We report here on the reobservation after 12 yr of the 328 OH/IR stars in the Arecibo sky with a peak first-epoch $I_{1612} > 100$ mJy. Four of these now have undetectable 1612 MHz masers, while those from a fifth, FV Boo, appear to be in terminal decline. The blue IR colors, 315 d period of FV Boo, and the presence of water & SiO masers in several of the newly-identified dead OH/IR stars all suggest that these objects are still AGB stars rather than proto planetary nebulae. This conclusion suggests that most oxygen-rich AGB stars pass through the OH/IR star phase more than once.

The positions of the dead OH/IR stars on first-epoch plots of I_{1612} v S(25), and on plots of the ratio of these quantities versus IR color, are entirely normal. However all of the dead OH/IR stars have small, < 12 km s^{-1}, expansion velocities, and all but one have blue IR colors. When these criteria are used to delimit the sample further, the 5 dead OH/IR stars in a sample of 112 imply a mean 1612 MHz emission life $t_e \sim 314$ (+387, -97) yr. The short duration of this emission phase is readily understood if oxygen-rich AGB stars toward the end of the AGB pass through a brief OH/IR star phase after a thermal pulse, when, as often happens, they are not bright enough to support heavy mass-loss on the luminosity ascent to a thermal pulse. Copious AGB mass-loss is thus frequently triggered by events following after a thermal pulse.

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For preprints, contact blewis@naic.edu
or ftp://ftp2.naic.edu/pub/publications/bml/deaths.pdf

Abstract of recently accepted papers

Circumstellar Distribution of Dust Grains around Proto-Planetary Nebulae:

Observational Evidence for Axisymmetry and 2.5-D Radiative Transfer Model Calculations

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e.g.: Thesis work conducted at: University of Illinois at Urbana-Champaign, USA

Ph.D dissertation directed by: Margaret Meixner

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Proto-planetary nebulae (PPNs) are evolved, intermediate initial mass ($0.8 - 8\ M_\odot$) stars that are in rapid transition from the asymptotic giant branch (AGB) phase into the planetary nebula (PN) phase. Largely spherically symmetric circumstellar dust shells of AGB stars are known to evolve into mostly axisymmetric PNs. Since the PPN phase predates the period of final PN shaping due to interacting stellar winds, the PPN shells preserve pristine records of AGB mass loss histories. Hence, the origin of the structure formation in the circumstellar shells is investigated by probing the density distribution in the PPN shells. First, presented are the results from imaging surveys of PPNs at the mid-infrared and optical. In these imaging surveys, a prevalent axisymmetry has been found to reveal the equatorially-enhanced (toroidal) structure of the PPN shells. Moreover, two morphological types (SOLE-toroidal and DUPLEX-core/elliptical PPNs) have been discovered among PPNs in each survey, which strongly suggest the optical depth of the PPN shells is an important determining factor of the PPN shell morphology. The combined results of the two surveys have indicated that the PPN shells are intrinsically axisymmetric due to equatorially-enhanced superwind mass loss occurring near the end of the AGB phase, and a variable degree of equatorial enhancement in the PPN shells yields distinct optical depths of the shells, which determine the shell morphologies. Second, we present a newly developed multi-dimensional radiative transfer code, 2-D$_{\rm DUST}$, and its results to derive physical parameters concerning the characteristics of the PPN dust shells without ambiguities arising from the inclination angle effect. Model calculations with a single dust density distribution function have reproduced all the observed morphologies quite well. Numerical analyses have suggested that the PPN shells are indeed highly equatorially-enhanced due to an axisymmetric superwind, and SOLE-toroidal PPNs originate from lower mass progenitor stars and become elliptical PNs while DUPLEX-core/elliptical PPNs arise from higher mass progenitor stars and evolve into bipolar PNs. These imaging and numerical analyses have yielded well-constrained models that need to be explained by future dynamical models.