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Abstract of recently accepted papers

The Galactic Disk Distribution of Planetary Nebulae With Warm Dust Emission Features: I

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We investigate the galactic disk distribution of a sample of planetary nebulae characterised in terms of their mid-infrared spectral features. The total number of galactic disk PNe with 8–13μm spectra is brought up to 74 with the inclusion of 24 new objects, whose spectra we present for the first time. 54 PNe have clearly identified warm dust emission features, and form a sample which we use to construct the distribution of the C/O chemical balance in galactic disk PNe. The dust emission features complement the information on the progenitor masses brought by the gas-phase N/O ratios: PNe with unidentified infrared emission bands have the highest N/O ratios, while PNe with the silicate signature have either very high N enrichment or close to none, and SiC emission features coincide with a range of moderate N-enrichments. We find a trend for a decreasing proportion of O-rich PNe towards the third and fourth galactic quadrants. Two independent distance scales confirmed that the proportion of O-rich PNe decreases from 30±9% inside the solar circle, to 14±7% outside. PNe with warm dust are also the youngest. PNe with no warm dust are uniformly distributed in C/O and N/O ratios, and do not appear to be confined to C/O$\sim$1. They also have higher 6 cm fluxes, as expected from more evolved PNe. We show that the *IRAS* fluxes are a good representation of the bolometric flux for warm-dust PNe. The requirement $F(12\mu\mathrm{m}) > 0.5\,\mathrm{Jy}$ should probe a good portion of the galactic disk, and the dominant selection effects are rooted in the PN catalogues.

Accepted by MNRAS

Preprints can be obtained by contacting simon@das.uchile.cl *or via WWW on* http://arXiv.org/abs/astro-ph/0009399

The Galactic Disk Distribution of Planetary Nebulae with Warm Dust Emission Features: II

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We address the question of whether the distribution of warm-dust compositions in IR-bright galactic disk PNe (paper I, Casassus et al. 2000), can be linked to the underlying stellar population. The PNe with warm dust emission represent a homogeneous population, which is presumably young and minimally affected by a possible dependence of PN lifetime on progenitor mass. The sample in paper I thus allows testing the predictions of single star evolution, through a comparison with synthetic distributions and under the assumption that tip-of-the-AGB and PN statistics are similar. We construct a schematic model for AGB evolution (adapted from Groenewegen & de Jong 1993), whose free-parameters are calibrated with the luminosity function (LF) of C stars in the LMC, the initial-final mass relation, and the range of PN compositions. The observed metallicity gradient and distribution of star forming regions with galactocentric radius (Bronfman et al. 2000) allow us to synthesise the galactic disk PN progenitor population. We find the fraction of O-rich PNe, f(O), is a tight constraint on AGB parameters. For our best model, a minimum PN progenitor mass $M^{\rm min} = 1$ M$_\odot$ predicts that about 50% of all young PNe should be O-rich, compared to an observed fraction of 22%; thus $M^{\rm min} = 1.2$ M$_\odot$, at a 2σ confidence level ($M^{\rm min} = 1.3$ M$_\odot$ at 1σ). By contrast, current AGB models for single stars can account neither for the continuous range of N enrichment (Leisy & Dennefeld 1996), nor for the observation that the majority of very C-rich PNe have Peimbert type I (paper I). f(O) is thus an observable much easier to model. The decrease in f(O) with galactocentric radius, as reported in paper I, is a strong property of the synthetic distribution, independent of $M^{\rm min}$. This trend reflects the sensitivity of the surface temperature of AGB stars and of the core mass at the first thermal pulse to the galactic metallicity gradient.

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Abundance in the planetary nebulae NGC 6537 and He2-111

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The ISO and IUE spectra of the bipolar planetary nebulae NGC 6537 and He2-111 are presented. These spectra are combined with the spectrum in the visual wavelength region from the nebulae to obtain a complete spectrum that is corrected for extinction. The chemical abundance of the nebulae is then determined and compared to previous determinations. The abundance of the two nebulae is quite similar. A comparison is then made with the abundance of two other bipolar planetary nebulae whose abundance is also determined with the help of ISO observations. It is shown that not all bipolar nebulae have similar abundance. NGC 6445 has a much lower nitrogen to oxygen ratio, similar to NGC 7027, but still not as low as the Orion nebula.

Accepted by Astronomy & Astrophysics Main Journal.

Preprints can be obtained by contacting pottasch@astro.rug.nl

Chandra X-ray Observatory Detection of Extended X-ray Emission from the Planetary Nebula BD +30 3639

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We report the detection of well resolved, extended X-ray emission from the young planetary nebula BD +30° 3639 using the Advanced CCD Imaging Spectrometer (ACIS) aboard the Chandra X-ray Observatory. The X-ray emission from BD +30° 3639 appears to lie within, but is concentrated to one side of, the interior of the shell of ionized gas seen in high-resolution optical and IR images. The relatively low X-ray temperature ($T_x \sim 3 \times 10^6$ K) and asymmetric morphology of the X-ray emission suggests that conduction fronts are present and/or mixing of shock-heated and photoionized gas has occurred and, furthermore, hints at the presence of magnetic fields. The ACIS spectrum suggests that the X-ray emitting region is enriched in the products of helium burning. Our detection of extended X-ray emission from BD +30° 3639 demonstrates the power and utility of Chandra imaging as applied to the study of planetary nebulae.

Accepted by the Astrophysical Journal (Letters)

Preprints can be obtained by contacting jhk@cis.rit.edu *or via WWW on* http://xxx.lanl.gov/archive/astro-ph (astro-ph/0010167)

Kinematics of Molecular Hydrogen Emission from Pre-planetary Nebulae: RAFGL 2688 and RAFGL 618

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We present high spectral resolution maps of near-infrared molecular hydrogen emission from the bipolar pre-planetary nebulae RAFGL 2688 and RAFGL 618, obtained with the NOAO Phoenix spectrometer. The measured velocity gradients along the polar axes of both nebulae indicate that the highest velocity gas lies closest to the central stars. These results support the suggestion that the polar H_2 emission regions of both nebulae contain shocked gas formed as fast ($\sim 50 - 150$ km s^{-1}), collimated, post-asymptotic giant branch (AGB) winds collide with slower-moving ($\sim 10 - 20$ km s^{-1}) material previously ejected while the central stars were still on the AGB. The kinematics of H_2 emission perpendicular to the polar axis of RAFGL 2688 are consistent with a model combining expansion along the equator at $5 - 10$ km s^{-1} with rotation about the polar axis at $5 - 10$ km s^{-1}. The rapid onset of the common envelope phase of a close binary system may explain both the bipolar structure of RAFGL 2688 and the presence and complex kinematics of its shocked H_2 emission.

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Discovery of Parsec-Sized Dust Shells Around AFGL 2688 and AFGL 618

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We present ISOPHOT linear scans of two carbon-rich protoplanetary nebulae, AFGL 2688 and AFGL 618. The 53' × 3' scans were made with the ISO AOT PHT32 using the 120 and 180μm filters. Both these objects appear to have very bright central point sources together with extremely extended (radius ∼350-400") dust shells with brightnesses of ∼10% of the peak brightness of the point source. Assuming constant expansion velocities, ages for these dust shells are of the order of 10^5 years. The infrared intensities do not fall off smoothly with radius as one would expect for constant or even steadily increasing mass-loss rates. Rather, AFGL 2688 and AFGL 618 both show enhanced emission at 150″ and 300″ and 160″ and 275″, respectively. These "periodic" enhancements indicate episodic variations in the mass loss with timescales (few times 10^4 yrs) that appear to coincide with thermal pulses on the asymptotic giant branch (AGB). Comparison of these timescales with theoretical calculations suggest a progenitor main sequence mass of ∼3 $M_\odot$ for both AFGL 2688 and AFGL 618.

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Preprints can be obtained by contacting akspeck@astro.uiuc.edu *or via WWW on* http://www.astro.uiuc.edu/ akspeck/witch-stuff/Research/Publications/

A Search for Jovian Planets around Hot White Dwarfs

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Current searches for extrasolar planets have concentrated on observing the reflex Doppler shift of solar-type stars. Little is known, however, about planetary systems around non-solar-type stars. We suggest a new method to extend planetary searches to hot white dwarfs. Near a hot white dwarf, the atmosphere of a Jovian planet will be photoionized and emit hydrogen recombination lines, which may be detected by high-dispersion spectroscopic observations. Multi-epoch monitoring can be used to distinguish between non-LTE stellar emission and planetary emission, and to establish the orbital parameters of the detected planets. In the future, high-precision astrometric measurements of the hot white dwarf will allow the masses of the detected planets to be determined. Searches for Jovian planets around hot white dwarfs will provide invaluable new insight on the development of planetary systems around stars more massive than the Sun and on how stellar evolution affects these systems. We present high-dispersion spectroscopic observations of the white dwarf Feige 34 to demonstrate the complexity and feasibility of the search method.

Accepted by the ApJ Letters

Preprints can be obtained by contacting chu@astro.uiuc.edu *or via WWW on* http://xxx.lanl.gov/abs/astro-ph/0010469

Astronomical detection of the free radical SiCN

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We report the detection of the SiCN radical in an astronomical source, the envelope of the C star IRC+10216/CW Leo. The microwave spectrum of SiCN was recently studied by four of us in the laboratory and the rotational transition frequencies were accurately measured. The ground fine structure state, $^2\Pi_{1/2}$, has three rotational transitions, each with λ-doubling in the 80–116 GHz atmospheric window ($J = 7.5 \rightarrow 6.5$, $8.5 \rightarrow 7.5$ and $9.5 \rightarrow 8.5$, at 83.0, 94.0, and 105.1 GHz). The three λ-doublets (six components) are detected at a level of 5 mK with the IRAM 30-m telescope. Judging from the cusped shape of the line profiles, SiCN is largely confined to the outer molecular envelope, like most other radicals. Its abundance relative to H_2 is estimated to be $4\ 10^{-9}$, a factor of 20 lower than that of MgNC.

The isoelectronic radical SiCCH was not detected. We confirm our previous tentative detections of the carbon chain H_2C_6 and of NP in IRC+10216.We report the detection of the SiCN radical in an astronomical source, the envelope of the C star IRC+10216/CW Leo. The microwave spectrum of SiCN was recently studied by four of us in the laboratory and the rotational transition frequencies were accurately measured. The ground fine structure state, $^2\Pi_{1/2}$, has three rotational transitions, each with λ-doubling in the 80–116 GHz atmospheric window ($J = 7.5 \rightarrow 6.5$, $8.5 \rightarrow 7.5$ and $9.5 \rightarrow 8.5$, at 83.0, 94.0, and 105.1 GHz). The three λ-doublets (six components) are detected at a level of 5 mK with the IRAM 30-m telescope. Judging from the cusped shape of the line profiles, SiCN is largely confined to the outer molecular envelope, like most other radicals. Its abundance relative to H_2 is estimated to be $4\ 10^{-9}$, a factor of 20 lower than that of MgNC.

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Preprints can be obtained by contacting guelin@iram.fr

Period–Luminosity–Colour distribution and classification of Galactic oxygen–rich LPVs – II. Confrontation with pulsation models

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The kinematic and Period–Luminosity–Colour distribution of O-rich Long-Period Variable stars of the solar neighbourhood is interpreted in terms of pulsation modes, masses and metallicities. It is first shown that, because of input physics imperfections, the periods and mean colours derived from the existing linear and nonlinear nonadiabatic models must significantly depart from the actual behaviour of the stars. As a consequence systematic corrections have to be applied, as a first approximation, to our linear model grid. These free parameters, as well as the mixing length, are calibrated on the LPVs of the LMC and of some globular clusters, assuming a mean mass of $1\,M_\odot$ for the LMC Mira-like stars. Then, the masses and metallicities corresponding to the four kinematic/photometric populations of local LPVs are evaluated. The possibility of a varying mixing-length parameter is discussed and taken into account. Stars of the old disk appear pulsating in the fundamental mode: one group, mainly composed of Miras, has mean mass $< M > \simeq 0.9\,M_\odot$ and mean metallicity $< Z > \simeq 0.02$, both strongly increasing with the period; a second group, slightly older and mainly composed of SRb's, has $< M > \simeq 0.9\,M_\odot$ and $< Z > \geq 0.03$. Stars of the thin disk appear pulsating in the first and second overtones, with $< M_{1ov} > \approx 1.05\,M_\odot$, $< M_{2ov} > > 0.75\,M_\odot$ and $< Z > \geq 0.04$. Stars of the extended disk/halo appear pulsating in the fundamental mode, with $< M > \simeq 1.1\,M_\odot$ and $< Z > \simeq 0.01$. The mixing-length parameter

probably decreases along the AGB by no more than 15 % per magnitude. The large, positive period corrections (more than 30 % for the fundamental and 8 % for the first overtone) that have to be applied to the LNA models used in this study do not seem to be explained by imperfect sub-photospheric physics alone, especially when nonlinear effects are taken into account. The origin of the extra period increase (at least 15 % for the fundamental mode) may be the stellar wind, which was neglected by all pulsation codes up to now.

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Preprints can be obtained by contacting xluri@am.ub.es *or via WWW on* http://xxx.lanl.gov/archive/astro-ph

Discovery of an Extended Dust Emission around IRAS 18576+0341 (AFGL 2298) at 10.3 and 18.0 microns: a New Luminous Blue Variable Candidate?

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We report detection of an extended mid-infrared emission from *IRAS* 18576+0341 (AFGL 2298). The object shows a dusty circumstellar shell that has diameter of > 7 arcseconds at 10.3 and 18.0 μm. The dust nebula shows two emission peaks concentrically elongated and symmetrically oriented on the opposite sides of the third, central peak, which appears to be the central star of the system. The observed mid-infrared morphology indicates that the circumstellar dust shell has an equatorially-enhanced material distribution, which is a common signature of stellar objects that have experienced mass loss. Radiative transfer model calculations suggest that the central star is an extremely bright ($L_* = 10^{6.4} L_\odot$) star at a distance of about 10 kpc: this object is best described as a new luminous blue variable candidate. The circumstellar dust shell seems to have been generated by an equatorially-enhanced mass loss process with $\dot{M} \geq 6.8 \times 10^{-6} M_\odot$ yr^{-1} and $\dot{M}_{\rm pole}/\dot{M}_{\rm eq} \sim 0.5$.

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Preprints can be obtained by contacting ueta@astro.uiuc.edu
or via WWW on http://www.astro.uiuc.edu/ ueta/project/ir18576/index.html

The approaching death of the OH/IR star IRAS 18455+0448

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1612 MHz observations of the OH/IR star IRAS 18455+0448 in June 1998 showed that its peak intensity had faded by a factor of 20 from its 2.09 Jy discovery-intensity in 1988. Its peak intensity, when observed at constant resolution, has faded exponentially since by a further factor of 10, with an e-folding time of 319 d. This decline is seemingly inexorable, even though the mainline OH masers are as yet largely unaffected, as the correlation between the expansion velocities and periods of OH/IR stars suggests a likely period of ~400

days for 18455+0448 as a long period variable, and our observations cover 706 d. We argue that extant data are best understood if we are witnessing an early stage in the expansion of a fossil circumstellar shell around 18455+0448, prior to it becoming a planetary nebula.

Accepted by ApJ (Letters) *For preprints, contact* blewis@naic.edu

Turbulent outflows from [WC]-type nuclei of planetary nebulae. I. BD +30° 3639 and other [WC 9–10] stars

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Using spectroscopic observations taken at the Observatoire de Haute-Provence (OHP, France) and the European Southern Observatory (ESO, Chile), we describe wind fluctuations in four [WC 9–10]-type central stars of planetary nebulae, especially BD +30° 3639, which was observed intensively during 15 nights. Moving features seen on the top of the CIIIλ5696 emission line are interpreted as outflowing "blobs" which are radially accelerated outwards, as seen in the winds of massive Wolf-Rayet stars. We find line profile variations occurring on a time scale of hours. Kinematic parameters of the blobs are derived and compared to those of massive Wolf-Rayet stars. The wind fragmentation process appears independent of the strong differences between both types of hot stars.

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Preprints can be obtained by

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Precessing collimated outflows in the planetary nebula IC 4846

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We present [N II] and Hα images and high resolution long–slit spectra of the planetary nebula IC 4846, which reveal, for the first time, its complex structure and the existence of collimated outflows. The object consists of a moderately elongated shell, two (and probably three) pairs of collimated bipolar outflows at different orientations, and an attached circular shell. One of the collimated pairs is constituted by two curved, extended filaments whose properties indicate a high velocity, bipolar precessing jet. A difference of $\simeq$ 10 km s^{-1} is found between the systemic velocity of the precessing jets and the centroid velocity of the nebula, as recently report for Hu 2-1. We propose that this difference is due to orbital motion of the ejection source in a binary central star. The orbital separation of $\leq$ 30 AU and period $\leq$ 100 yr estimated for the binary are similar to those in Hu 2-1, linking the

central stars of both planetary nebulae to interacting binaries. Extraordinary similarities also exist between IC 4846 and the bewildering planetary nebula NGC 6543, suggesting a similar formation history for both objects.

Accepted by MNRAS

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University of Hertfordshire Department of Physical Sciences

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Further details of the above post and application forms can be obtained from the Personnel Department at the University of Hertfordshire, College Lane, Hatfield, Hertfordshire AL10 9AB, England, or telephone 01707 284802, quoting reference number T2676. Applications (which should be accompanied by a full CV and personal statement) should be returned to the Personnel Department.

Applicants should arrange for 2 references to be sent directly to Personnel. Closing date is December 15 2000.

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