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Abstract of recently accepted papers

Binary (post-) AGB evolution

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In this contribution the observational characteristics of F to G type post-AGB stars, showing both O-rich and C-rich circumstellar chemistry, are reviewed. It turns out that binarity and the presence of a stable circumbinary dusty disc are fundamental properties of these objects. The possible common origin of the mixed chemistry observed in these systems and in IR-bright [WC] stars is discussed.

To appear in the proceedings of "Low mass Wolf-Rayet Stars: origin and evolution", eds. L.B.F.M. Waters, A.A. Zijlstra (Astrophysics and Space Science)

Preprints can be obtained by contacting Hans.VanWinckel@ster.kuleuven.ac.be
or via WWW on http://www.ster.kuleuven.ac.be/homepage/publications.html

ROSAT observations of X-ray emission from planetary nebulae

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We have searched the entire ROSAT archive for useful observations to study X-ray emission from Galactic planetary nebulae (PNs). The search yields a sample of 63 PNs, which we call the ROSAT PN sample. About 20–25% of this sample show X-ray emission; these include 13 definite detections and three possible detections (at a 2σ level). All X-ray sources in these PNs are concentrated near the central stars. Only A 30, BD+30°3639, and NGC 6543 are marginally resolved by the ROSAT instruments.

Three types of X-ray spectra are seen in PNs. Type 1 consists of only soft X-ray emission (<0.5 keV), peaks at 0.1–0.2 keV, and can be fitted by blackbody models at temperatures $1 - 2 \times 10^5$ K. Type 2 consists of harder X-ray emission, peaks at > 0.5 keV, and can be fitted by thin plasma emission models at temperatures of a few 10^6 K. Type 3 is a composite of a bright Type 1 component and a fainter Type 2 component.

Unresolved soft sources with Type 1 spectra or the soft component of Type 3 spectra are most likely photospheric emission from the hot central stars. Absorption cross sections are large for these soft-energy photons; therefore, only large, tenuous, evolved PNs with hot central stars and small absorption column densities have been detected.

The origin of hard X-ray emission from PNs is uncertain. PNs with Type 2 spectra are small, dense, young nebulae with relatively cool ($\ll 10^5$ K) central stars, while PNs with Type 3 X-ray spectra are large, tenuous, evolved nebulae with hot central stars. The hard X-ray luminosities are also different between these two types of PNs, indicating perhaps different origins of their hard X-ray emission. Future Chandra and XMM observations with high spatial and spectral resolution will help to understand the origin of hard X-ray emission from PNs.

To appear in ApJS

Preprints can be obtained by contacting mar@astro.uiuc.edu
or via WWW on http://www.astro.uiuc.edu/~mar/preprints/

Optical long-slit spectroscopy and imaging of OH 231.8+4.2

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We present optical long-slit spectra and complementary broad and narrow band images of the bipolar proto-planetary nebula OH 231.8+4.2. Absolute J2000 coordinates have been calculated for our maps from the position of nearby stars. Our maps of the optical continuum show the spatial distribution of the starlight scattered by dust grains. This component is found to be highly elongated along the nebular axis, with a structure very similar to that of the molecular emission. Flux variations with time of the red continuum emission are detected. Our long-slit spectroscopy of Hα and other atomic lines reveals wide spectral profiles and, in general, a complex spatial and spectral emission distribution. The emission arises from two broad lobes and is shifted toward shorter (north lobe) and longer wavelengths (south lobe), indicating that the gas is flowing outwards at high velocity. The clumpiness of the emission nebula is remarkable. A simple model has been used to describe the complex structure and kinematics of this source. Our model suggests that, in addition to the two extended, hollow lobes identified in the Hα images, a smaller, bubble-like expanding structure should lie inside the south lobe. A comparison of the emission line spectrum with predictions of theoretical shock models confirms that the optical lines have been shock excited. We have estimated the electron density of the lobes and deduced the total ionized mass of the nebula, obtaining a low value of $\sim 5{\times}10^{-4}\,M_{\odot}$. We interpret the shaping and evolution of OH 231.8+4.2 in the wind interaction scenario for planetary nebulae formation. The peculiar structure and kinematics of the molecular outflow and the ionized envelope are explained in terms of a shock regime transition: the well collimated molecular outflow and the different components of the optical nebula would consist of circumstellar material swept-up by a unique shock in a radiative, and non-radiative regime, respectively. Finally, we briefly discuss the controversial evolutionary status of OH 231.8+4.2.

Accepted by A&A

Preprints can be obtained by contacting sanchez@oan.es

Optical properties of the carbon dust grains in the envelopes around asymptotic giant branch stars

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We have investigated the optical properties of the carbon dust grains in the envelopes around carbon-rich asymptotic giant branch stars, paying 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 have deduced an opacity function of amorphous carbon (AMC) dust grains from model fitting with infrared carbon stars. From the opacity function, we have derived the optical constants of the AMC grains. The optical constants satisfy the Kramers-Kronig relation and produce the opacity function that fits the observations of infrared carbon stars better than previous works in the wide wavelength range 1 to 1000 μm. We have used simple mixtures of the AMC and SiC grains for modelling. We have compared the contributions of AMC and SiC grains to the opacity for the cases of simple mixtures of them and spherical core-mantle type grains consisting of a SiC core and a AMC mantle. All the optical data discussed in this paper are accessible through the author's world wide web site http://ast.chungbuk.ac.kr/~kwsuh/kwsuh.htm.

Accepted by MNRAS

Preprints can be obtained by contacting kwsuh@cbucc.chungbuk.ac.kr
or via WWW on http://ast.chungbuk.ac.kr/~kwsuh/kwsuh.htm

Studies of Mira and semiregular variables using visual databases

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We used wavelets to investigate period and amplitude changes in Mira and semiregular variables and found a variety of behaviours. Period and amplitude changes often go together, perhaps because changes in amplitude are causing period changes via non-linear effects.

To appear in Proc. IAU Colloquium 176, The Impact of Large-Scale Surveys on Pulsating Star Research, ASP, edited by L. Szabados and D.W. Kurtz.

Preprints can be obtained by contacting bedding@Physics.usyd.edu.au
or via WWW on http://xxx.lanl.gov/abs/astro-ph/9911070

The complex environment of the high excitation planetary nebula NGC 3242

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Spatially resolved profiles of the Hα, [N II] and [O III] nebular emission lines, obtained with the Manchester echelle spectrometer combined with the 2.1 m San Pedro Mártir telescope have revealed the velocity structure of the nebular core and of one of the three (A, B and C) inner 'haloes' of the high excitation planetary nebula NGC 3242. The core is shown to have a cylindrical structure expanding at 25 km s^{-1}. The bright, diffuse, line emitting, inner spherical halo A surrounding the intensely bright elliptical core is shown to be limb brightened but its expansion velocity is unclear. The surrounding diffuse, 2.5 pc diam., halo B, is modelled by a thick shell expanding at 20 km s^{-1} although the contribution of scattered [O III] emission is unknown at present. The origin of the broad profiles from the fainter, patchy, 0.44 pc diam., halo C is again somewhat uncertain and may originate in scattered core light. FIR observations with IRAS and ISO reveal the presence of warm dust throughout the core and inner haloes on NGC 3242. Alternatively, the split profiles could imply an expansion velocity of around 20 km s^{-1} for halo C if scattering is discounted.

There is a large filamentary structure of line emitting gas 1.7 pc to the west of the nebular core. This is shown to be the western boundary of extended FIR emission from warm dust. A patchy component associated

with this filamentary nebulosity emits the [O III] line with anomalous high intensity yet is shown here to be kinematically relatively inert. Likewise [N II] profiles from the filamentary edge are very narrow with turbulent motions of 8 km s^{-1}. Certainly the arc is being photoionised by leakage radiation from NGC 3242 but the radial velocities of the line profiles are inconsistent with its origin as a simple shell expanding radially from this PN. An asymmetric lobe remains a possibility in which case the arc could be an ancient halo of NGC 3242. The more mundane possibility that the arc is simply photoionised ambient gas is not completely ruled out by the present observations.

Strange, faint, broad [O III] line profiles are found over the whole 15 arcmin diameter area being considered here. The extended FIR emission region implies the presence of hot dust and suggests therefore that these [O III] line profiles could have a scattered origin.

Accepted by The Astrophysical Journal Supp. Series.

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High-resolution optical spectra of V854 Centauri

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High-resolution optical spectra of the R Coronae Borealis (RCB) star V854 Centauri in the early stages of a decline show, in addition to the features reported for other bright RCBs in decline, narrow absorption lines for the C_2 Phillips system. The low rotational temperature, T_{rot} = 1150K, of the C_2 ground electronic state suggests the cold gas is associated with the developing shroud of carbon dust. These absorption lines were not seen at a fainter magnitude on the rise from minimum light nor at maximum light. This is the first detection of cold gas around a RCB star.

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Preprints can be obtained by contacting contact nkrao@iiap.ernet.in

The formation of a multiple planetary nebula: HST/WFPC2 observations of KjPn 8

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KjPn 8 is an extreme poly-polar planetary nebula with a large-scale structure characterized by a giant, biconical envelope. Spasmodic bipolar ejections, in changing directions have occurred over thousands of years to create this peculiar nebula. Narrow-band images of the core of KjPn 8 have now been obtained with the WFPC2 camera on board the Hubble Space Telescope (HST) and are reported here. The central star is finally revealed in these observations and its compact nebular core is resolved into a remarkably young elliptical ring, currently expanding at only 16 kms^{-1}. This ring is the ionized inner region of larger molecular CO and H_2 counterparts, all sharing the same orientation. The highest speed and youngest outflows are perpendicular to this central ring, which is identified as the latest event in the creation of this nebula. It is shown that the formation history of KjPn 8 has involved two distinct and consecutive planetary nebulae-like events, probably originating from a

binary core evolution with components of very similar mass. These characteristics indicate that KjPn 8 may be a rare object in our Galaxy and the first ever detected of this class.

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Collimated Outflows in Planetary Nebulae

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Our understanding of the formation of planetary nebulae (PNe) has been profoundly influenced in recent years by the detection of high-velocity, collimated outflows in these objects. Outflows reaching expansion velocities of several hundred km s^{-1} and evidences of episodic, multiple ejection events since the proto-PNe stage, have radically modified our previous concepts on the evolution of post-AGB objects. Hydrodynamic models alone seem now incapable of reproducing many of the attendant dynamical phenomena observed in PNe. MHD models and binary nuclei are thus playing an increasingly important role in interpreting the diversity of collimated outflows in PNe. This paper presents and overview of these phenomena and discuses some of the current challenges and trends in the field

Invited talk, to appear in Astrophysical Plasmas: Codes, Models and Observations. Rev. Mex, Astron. Astrof. Conf. Series, vol. 9, S. J. Arthur, N. Brickhouse & J. Franco, eds.

Preprints can be obtained by contacting jal@astrosen.unam.mx
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SiO Maser Survey of the Galactic Disk IRAS Sources. II. $|l| \leq 3°$ and $|b| \leq 3°$, the Galactic Center Area

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A survey has been made in the SiO J =1–0, v =1 and 2 transitions ($\sim$ 43 GHz) for the color-selected IRAS sources in the galactic-center region of $|l| \leq 3°$ and $|b| \leq 3°$ with the Nobeyama 45-m telescope. We have detected 86 out of 176 observed sources in the SiO masers. Distances to the sources are deduced from the IRAS 12 and 25 μm flux densities and range approximately from 5 kpc to 12 kpc. Radial velocities of the detected sources spread between -300 km $s^{-1}$and 310 km s^{-1}. The longitude–velocity (l–v) diagram exhibits an empty region of sources at $l = -0.4$–$1.0°$ and V_{lsr} = 20–150 km s^{-1}, which is interpreted as an undersampling effect of sources in the IRAS catalog at the galactic central disk. The rotation rate, the velocity dispersion, the tilt angle of the rotation axis, and the velocity shift at $l = 0°$ are derived by fitting the velocities of the sources with a straight line as a function of the galactic longitude. These quantities are compatible with those obtained from the previous observations for the bulge stars with $|b| > 3°$. The average radial velocity of subsamples of

stars tends to increase with distances, suggesting evidence of streaming motion of stars in a bar-like bulge. We conclude that most of the IRAS sources in the sample belong to the bulge.

APJ Suppl. Ser. 128 No. 2 (2000 June. issue) in press

Preprints can be obtained by contacting deguchi@nro.nao.ac.jp
or via WWW on http://www.nro.nao.ac.jp/~eiko/nroreport/
or via anonymous ftp on ftp://ftp.nro.nao.ac.jp/nroreport/nro513.gz

Messages

ALMA Scientific Advisory Committee

The Atacama Large Millimeter Array (ALMA) project has formed a new committee to provide scientific advice to the project and outreach to the wider community. We hold monthly telecons and hold other meetings at regular intervals. The minutes of the telecons and reports from the meetings are placed on the following web site.

http://www.alma.nrao.edu/committees/ASAC/index.html

A list of the committee members can also be found on this web site. Comments or questions can be addressed directly to the individual committee members or to the committee by email via the website. In addition, we are all willing to give colloquia or other presentations on the ALMA project.

New Jobs

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Further details can be found at: http://www.astro.univie.ac.at/IfA/vacancy.html

Postdoctoral Research Associateship in Circumstellar Astrophysics
University College London - Department of Physics and Astronomy

Applications are invited for a Postdoctoral Research Associate position to work with Professor Mike Barlow on infrared studies of circumstellar matter. The research, which is funded by PPARC, will involve the study of circumstellar disks around Vega-like main sequence stars and the analysis of the water vapour and dust emission ISO spectra of evolved stars. A related aim is to use the soon to be commissioned 10- and 20-um imager/spectrometer MICHELLE on the 3.8-m UKIRT and 8.2-m Gemini-N telescopes, in order to make high angular resolution spectroscopic and imaging studies of circumstellar dust located around such sources.

The candidate should be able to start by July 1st 2000. The salary will be in the range (GBP) 16,286 to 24,479 per annum, depending upon age and experience, plus a London Allowance of (GBP) 2134 per annum. Sufficient funding exists to support this position for two and a half years. Informal enquiries about the post may be made by email to Professor Mike Barlow, mjb@star.ucl.ac.uk.

To apply, please send a curriculum vitae, a publication list, a 2-3 page description of your research interests and the names of two referees to:

Professor M. J. Barlow
Dept. of Physics and Astronomy
University College London
Gower Street, London WC1E 6BT
U.K.

Applications should be received by 27 March 2000. Candidates should ask the two referees to write or email directly by this date also.
University College London is an equal opportunity employer.

Abstracts of the APN II Conference invited papers

To appear in: *Asymmetrical Planetary Nebulae II: From Origins to Microstructures* **(Astronomical Society of the Pacific Conference Series, Volume 199, 2000; Kastner, Soker, & Rappaport, eds.)**

Preprints can be obtained from http://www.cis.rit.edu/research/astro/apn/papers.htm *or by contacting authors using e-mail addresses listed on this Web page*

From Historical Perspectives to Some Modern Possibilities

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A historical perspective on the study of asymmetries in planetary nebulae (PNs) is presented. We also describe our ongoing work in high resolution spectroscopy of planetaries, and discuss some likely future directions for the study of asymmetrical PNs.

A Retrospective: Interacting Winds Theory, Two Decades Later

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The role of the interacting stellar winds (ISW) model in our modern understanding of planetary nebulae formation and evolution is reviewed. The physical origin of the observed morphological diversity of planetary nebulae is discussed in terms of the ISW model. The possibility that the observed morphological classes of planetary nebulae can be explained by a universal model is also considered.

The Morphological and Structural Classification of Planetary Nebulae

Arturo Manchado [1], *Eva Villaver* [1], *Letizia Stanghellini* [2], *Martín A. Guerrero* [3]

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We present a statistical analysis of a complete sample (255) of northern planetary nebulae (PNe). Our analysis is based on morphology as a main parameter. The major morphological classes are: round (26% of the sample), elliptical (61%), and bipolar (13%) PNe. About a half of the round and 30 % of the elliptical PNe present multiple shells. Round PNe have higher galactic latitude ($|b| = 12$) and galactic height ($< z > = 753$ pc), than the elliptical PNe ($|b| = 7$, $< z > = 308$ pc) and bipolar PNe ($|b| = 3$, $< z > = 179$ pc). This possibly implies a different progenitor mass range across morphology, as a different stellar population would suggest.

Morphology vs. Physical Properties: Some Comments and Questions

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Some of the correlations between morphological and other physical properties of planetary nebulae (PNe) are reviewed.

In particular, the finding that bipolar b PNe have more massive progenitors than the other morphological classes is discussed in detail. Earlier results are confirmed; including all the various sources of uncertainty, the Galactic distribution of objects indicate that b PNe are formed by stars with initial masses > 1.3 $M_\odot$ while elliptical e PNe by progenitors with masses < 1.3 $M_\odot$.

Recent results for the chemical abundances of b and e PNe and their orientation within the Galaxy are also presented.

Finally, the key role in the discussion of the formation of b PNe played by detached binary systems such as symbiotic stars is briefly discussed.

To appear in: *Asymmetrical Planetary Nebulae II: From Origins to Microstructures* **(Astronomical Society of the Pacific Conference Series, Volume 199, 2000; Kastner, Soker, & Rappaport, eds.)**

Planetary Nebulae with the Hubble Space Telescope

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The Hubble Space Telescope has provided dozens of high resolution images of planetary and proto-planetary nebulae that include a wealth of new information about these objects. Here we discuss the nebular rings, FLIERs, expansions and morphological models of these objects. We also provide a World Wide Web Atlas of HST planetary nebulae images at `http://aries.usno.navy.mil/ad/pne/`.

Bipolar Planetary Nebulae: the Bêtes-Noires of Hydro Models

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Interacting Stellar Winds ("ISW") scenarios generally invoke a dense ring or torus of gas near the central star in order to collimate a (presumed) isotropic wind outflow that can account for the shapes of bipolar PNe, bPNe. However, HST/WFPC2 images of bPNe show embarrassing gaps between the nucleus and the inner portions of the collimated flow in more than half of known bipolars. In other cases a possible nozzle is resolved on scales of 10^{15} cm or larger. However, this size scale is much larger than expected for scenarios based on tidal forces and spin up by an orbiting companion.

Magnetic collimation also seems consistent with at least some of the images of bipolar PNe. But models tests need to be devised and executed before the concept is credible.

Properties of AGB Star Progenitors

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In this paper, two separate topics are discussed. Firstly, shells around AGB stars are considered. The highly spherical shells seen in microwave lines around some AGB stars are readily explained in terms of helium shell flash behaviour. On the other hand, deep images of AGB and post-AGB stars show that in some of them, the almost spherically symmetric AGB wind is modulated on a timescale of a few hundred years, much shorter than the helium shell flash timescale. Some single star explanations for this modulated are investigated: no single star mechanism appears satisfactory, although merging of mass shells produced near the AGB star by pulsation and dust formation needs further investigation. Secondly, binarity in AGB stars is discussed. In particular, it

is noted that observations of variable AGB stars in the LMC indicate that ∼25% of them show long secondary periods consistent with that expected for the orbital period of a close companion. If it turns out that the long secondary periods are indeed the result of a close orbiting companion, then it is almost certain that these companions will lead to the axially symmetric mass ejection observed in many planetary nebulae.

On the Transition from AGB Stars to Planetaries: The Spherical Case

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We discuss the basic physical model and the relevant processes responsible for creating and shaping planetary nebulae out of a cool AGB wind envelope. We show that a hydrodynamical treatment along the upper AGB leads quite naturally to more realistic starting configurations for planetaries with density slopes steeper than r^{-2}. Taking into account photoionization and wind interaction in a realistic manner, the hydrodynamics of post-AGB wind envelopes leads to density structures and velocity fields in close resemblance to observations of spherical or elliptical planetary nebulae.

Binarity of Central Stars of Planetary Nebulae

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I list the 16 planetary nebulae (PNe) known to contain close-binary nuclei, and show that the nebulae generally have axisymmetric structures, including elliptical, bipolar, or ring morphologies. The orbital periods range from 2.7 hr to 16 days, and close binaries constitute $\approx 10\%$ of all central stars. Since the known binaries were found mainly from photometric variability, which depends on heating effects at very small stellar separations, radial-velocity surveys will be necessary to find the large predicted population of binary nuclei with periods of about 10-100 days. Other PN phenomena that may arise from binary-star interactions include jets and point-symmetry, the periodically spaced arcs revealed by *HST* in the faint halos around several PNe and proto-PNe, and the existence of PNe in globular clusters. There is thus considerable circumstantial evidence that binary-star processes play a major role in the formation and shaping of many or even most PNe.

The Formation of Very Narrow Waist Bipolar Planetary Nebulae

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We discuss the interaction of the slow wind blown by an asymptotic giant branch (AGB) star with a collimated fast wind (CFW) blown by its main sequence or white dwarf companion, at orbital separations in the range of several AU $\lesssim$ a $\lesssim$ 200 AU. The CFW results from accretion of the AGB wind into an accretion disk around the companion. We argue that such systems are the progenitors of bipolar planetary nebulae and bipolar symbiotic nebulae with a very narrow equatorial waist between the two polar lobes. The CFW wind will form two lobes along the symmetry axis, and will further compress the slow wind near the equatorial plane, leading to the formation of a dense slowly expanding ring. We conduct a population synthesis study of the formation of planetary nebulae in wide binary systems which quantitatively supports the proposed model. The population synthesis code follows the evolution of both stars and their arbitrarily eccentric orbit, including mass loss via stellar winds, for 5×10^4 primordial binaries. We show the number of expected systems that blow a CFW is in accord with the number found from observations, to within the many uncertainties involved. Overall, we find that $\sim 5\%$ of all planetary nebulae are bipolars with very narrow waists. Our population synthesis not only

supports the CFW model, but more generally supports the binary model for the formation of bipolar planetary nebulae.

Properties of Proto-Planetary Nebulae

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This review describes some general properties of proto-planetary nebulae with particular emphasis on the recent work of morphological studies. The weight of observational evidence shows that proto-planetary nebulae (PPNe) are most certainly axisymmetric like planetary nebulae. Recent work suggests two subclasses of PPNe optical morphology, DUst-Prominent Longitudinally-EXtended (DUPLEX) and Star-Obvious Low-level Elongated (SOLE). Radiative transfer models of an example DUPLEX PPN and SOLE PPN, presented here, support the interpretation that DUPLEX and SOLE are two physically distinct types of PPNe. The DUPLEX PPNe and SOLE PPNe may well be the precursors to bipolar and elliptical PNe, respectively.

A Debate: Single Stars or Binary Systems as Progenitors of Bipolar Planetary Nebulae?

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The origins of bipolar structure in planetary nebulae are debated. In particular, we examine whether the progenitor stars of bipolar nebulae most likely (always?) reside in binary systems, or whether such nebulae can arise from the evolution of single stars.

Hubble Space Telescope Observations of Young Planetary Nebulae

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We present results from an ongoing Hubble Space Telescope Hα imaging survey of young planetary nebulae (PNe), selected on the basis of their low excitation characteristics. All objects imaged so far show highly aspherical morphology, with a majority characterised by multipolar bubbles distributed roughly point-symmetrically around the central star. In some objects, bipolar ansae or collimated radial structures are seen, indicating the presence of jets, whereas in others bright structures near the minor axes indicate the presence of disks or torii. The complexity, organization and symmetry of the above structures leads us to propose that the primary agent for shaping PNe are high-speed collimated outflows or jets which operate during the late AGB and/or early post-AGB evolutionary phase. These outflows carve out a complex imprint within an intrinsically spherical AGB circumstellar envelope (CSE). Subsequent expansion of a hot, tenuous stellar wind from the post-AGB star inside the imprinted AGB CSE then produces the observed PN, whose shape and structure depend in detail on how the characteristics of the jets change with time.

A Paradigm Lost: New Theories for Aspherical Planetary Nebulae

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Theoretical Models for the shaping of PNe are reviewed in light of new high resolution images. The new data indicate the purely hydrodynamic interacting stellar winds model can not recover the full variety of shapes and kinematics. New models, some speculative, others more firmly grounded are discussed. In particular, accretion disks and magnetic fields are identified as two of the most promising avenues of future research. Outstanding issues such as jet formation by PNe disks and dynamo activity in P-AGB stars remain to studied. Finally, new simulations of the Egg Nebula are presented as an example of a "paleontological" study designed to recover the history of an individual object.

Magnetohydrodynamic Models for Planetary Nebulae

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In this work, we address several controversial features that appear in Planetary Nebulae which are easily solved by the inclusion of magnetohydrodynamic effects. These features include the presence of axisymmetric flows, confinement of flows, linearly encreasing kinematics of collimated outflows and asymmetrical morphologies such as point-symmetric nebulae.

Jets in Planetary Nebulae

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It is assumed that the acceleration and collimation mechanisms of jets are the same in all the classes of astrophysical objects which are observed to produce jets. These classes now include such objects as: active galactic nuclei, young stellar objects, massive x-ray binaries, black hole x-ray transients, symbiotic systems, planetary nebulae, supersoft x-ray sources, and possibly recurrent novae.

On the basis of this assumption, an attempt is made, to identify the necessary ingredients for the acceleration and collimation mechanism. It is argued that: (i) jets are produced mainly at the center of accretion disks, and are accelerated and collimated hydromagnetically, (ii) the production of *powerful* jets requires a hot corona or access to an additional energy source associated with the central object. Tentative explanations for the presence of jets in some classes of objects and absence in others are given. Some critical observation that can test the ideas presented in this paper are suggested.

Molecules as Tracers of Planetary Nebula Structure

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Molecular gas plays an important role in the structure of planetary nebulae: it is a major component of the equatorial tori of bipolar nebulae, it forms the cores of globules and related microstructures, and is the likely origin of multiple arcs. It is also a key component during the early stages of formation where interactions with outflows or jets provide an important shaping mechanism.

Abundances and Morphology in Planetary Nebulae

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The abundances of 16 well studied have been determined. New ISO measurements have been combined with optical and ultraviolet data from the literature, in an attempt to obtain accurate values. Only He, O, C, N, Ne, Ar, and S are considered. High values of N/O are sometimes, but not always, found in bipolar nebulae. On the other hand, some bipolar nebulae show low values of N/O, and it is concluded that no simple relationship between morphology and composition exists.

Theory of the Interaction of Planetary Nebulae with the Interstellar Medium

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The theory of the interaction of planetary nebulae with the interstellar medium is important for the interpretation of nebular morphologies that deviate from point symmetry. It can be used to probe the interstellar medium and its magnetic field. We emphasize in this review the role of hydrodynamical instabilities in the interaction.

Molecular Line Observations of Proto-planetary Nebulae

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We present our recent results on mm-wave CO observations of proto-planetary nebulae. These include high-resolution interferometric maps of various CO lines in three well known bipolar PPNe: M 1–92, M 2–56 and OH 231.8+4.2. The global properties of the high velocity molecular emission in post-AGB sources have been also studied, by means of high-sensitivity single dish observations of the J=1–0 and 2–1 lines of ^{12}CO and ^{13}CO. We discuss the implications of these results to constrain the origin of the post-AGB molecular high-velocity winds and the shaping of bipolar PPNe and PNe. In addition, we also present the results of an interferometric map of the molecular envelope around the luminous high-latitude star 89 Her, a low mass post-AGB source which is also a close binary system.

Kinematics of Molecular Hydrogen Emission from Planetary and Pre-planetary Nebulae

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We report results from a program of high-resolution spectral mapping of rotational H_2 emission from bipolar planetary and pre-planetary nebulae. Long-slit spectra obtained with the NOAO Phoenix near-infrared spectrometer allow us to probe the molecular kinematics of these nebulae at moderate spatial resolution. We find strong evidence of a component of rotation in the equatorial H_2 emission from the Egg nebula (RAFGL 2688). In this nebula and in the pre-planetary nebula RAFGL 618, the H_2 kinematics point to the recent emergence of high-velocity polar flows, which likely mark the fairly sudden terminations of the red giant phases of their central stars. The classical bipolar planetary NGC 2346 displays distinct kinematic components, which we interpret as arising in the morphologically distinct equatorial and polar regions of the nebula. The H_2 rings

observed in the Phoenix position-velocity maps of this nebula support the hypothesis that ring-like planetaries that display H_2 emission possess bipolar structure.

The Kinematics of Point-Symmetric Planetary Nebulae: Observational Evidence of Precessing Outflows

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The discovery of collimated outflows associated with point-symmetric features in Planetary Nebulae has proliferated in recent years. The systematic variation of radial velocity that many of them show strongly suggests a uniform rotation or precession of the ejection direction. Although several physical processes have been invoked, the formation mechanism of precessing collimated outflows in PNe is currently an intriguing but unresolved problem.

Do the Nuclei of Elliptical Galaxies Eat Planetary Nebulae?

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The dusty gas observed in elliptical galaxies must ultimately be derived from the population of planetary nebulae. However, if this gas had passed through the hot phase, most of the dust it contains would have been destroyed. In this paper we show that ram-pressure stripping of PNe envelopes in a high pressure interstellar environment can recompress the dusty material ejected during the AGB phase of evolution, and allow cold dusty clouds to fall intact towards the central regions of the galaxy, there to be available to power the active nucleus.

Conference Impression

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This paper gives a personal impression of the conference "Asymmetrical Planetary Nebulae II: From Origins to Microstructures," flags some of the highlights, gathers together some facts and terminology, and indicates some promising future lines of work in this field.