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Abstracts of recently accepted papers

The nature and structure of the emission line nebula K 3-35: A very young planetary nebula with precessing bipolar jet-like outflows?

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We present Hα, [NII]6583 and 6 cm continuum images of the emission line nebula K 3-35. The optical images reveal an extended nebula (size $\simeq 11'' \times 9''$ in [NII]) in which most of the emission originates in a very narrow (width 0.7″–1.3″) S-shaped region which extends almost all along the nebula ($\simeq 7''$). The 6 cm continuum emission also arises in this narrow region which is characterized by an exceedingly high point-symmetry and systematic and continuous changes of the orientation with respect to the nebular centre. The properties of the narrow region suggest that it represents a system of precessing bipolar jet-like components. Two low–excitation, compact bipolar knots near the tips of the jet-like components are observed in the deduced [NII]/Hα image ratio. These knots may be generated by the interaction of the collimated outflows with surrounding material. A comparison of the optical and radio images shows the existence of differential extinction within the nebula. Maximum extinction is observed in a disk-like region which traces the equator of the elliptical shell previously observed at 20 cm continuum. All available data strongly suggest that K 3-35 is a very young planetary nebula in which we could be observing the first stages of formation of collimated outflows and point-symmetric structures typically observed in planetary nebulae. The properties of the jet-like components in K 3-35 are in good agreement with models of binary central stars in which highly collimated outflows originate either from a precessing accretion disk or via magnetic collimation in a precessing star.

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Preprints can be obtained by contacting lfm@iaa.es

Spectrophotometry of the planetary nebula KjPn 8

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Flux-calibrated low-resolution spectra covering the optical wavelength range from 3400 to 7500 Å, have been obtained over the central region and the surroundings of the extraordinary planetary nebula (PN) KjPn 8

(PNG 112.5-00.1). The spectrum from the core is of low excitation with $T_e(\mathrm{N\,II}) = 8000\,\mathrm{K}$ and $n_e(\mathrm{S\,II}) = 550\,\mathrm{cm}^{-3}$. KjPn 8 is found to be a Type I PN according to the original classification scheme of Peimbert & Torres-Peimbert (1983), with enriched He/H and N/O ratios with respect to mean values for PN. Increased O/H, Ne/H and Ar/H ratios over those of average PN reflect the possible metal-rich environment from which the progenitor star formed, and also are similar to those found in the extreme Type I PN He 2-111. The N/H ratio is found to be only moderately high compared to the average PN and consequently, the large O abundance pulls the N/O ratio towards the lower limit of the criterion for Type I planetary nebulae (PNe) in this case. In addition, the spectra of some knots and faint regions in the KjPn 8 surroundings are presented, which show only a few spectral lines. Low electron densities ranging from 100 to $300\,\mathrm{cm}^{-3}$ have been derived in these outer regions.

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Preprints can be obtained by contacting vazquez@iaa.es
or via WWW on http://www.iaa.es/∼vazquez/preprints

The kinematics of 867 galactic planetary nebulæ

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We present a compilation of radial velocities of 867 galactic planetary nebulæ. Almost 900 new measurements are included. Previously published kinematical data are compared with the new high-resolution data to assess their accuracies. One of the largest samples in the literature shows evidence for a systematic velocity offset. We calculate weighted averages between all available data. Of the final values in the catalogue, 90% have accuracies better than $20\,\mathrm{km\,s}^{-1}$. We use this compilation to derive kinematical parameters of the galactic differential rotation obtained from least-square fitting and to establish the Disk rotation curve; we find no significal trend for the presence of an increasing external rotation curve. We examine also the rotation of the bulge; the derived curve is consistent with a linearly increasing rotation velocity with l: we find $V_{b,r} = (9.9 \pm 1.3)l - (6.7 \pm 8.5)\,km\,s^{-1}$. A possible steeper gradient in the innermost region is indicated.

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Birth and early evolution of a planetary nebula

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The final expulsion of gas by a star as it forms a planetary nebula — the ionized shell of gas often observed surrounding a young white dwarf — is one of the most poorly understood stages of stellar evolution. Such nebulae form extremely rapidly (∼100 years for the ionization) and so the formation process is inherently difficult to observe. Particularly puzzling is how a spherical star can produce a highly asymmetric nebula with collimated outflows. Here we report optical observations of the Stingray Nebula which has become an ionized planetary nebula within the past few decades. We find that the collimated outflows are already evident, and we

have identified the nebular structure that focuses the outflows. We have also found a companion star, reinforcing previous suspicions that binary companions play an important role in shaping planetary nebulae and changing the direction of successive outflows.

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Preprints can be obtained by contacting mattb@cta.com

FLIERs and other microstructures in Planetary Nebulae. IV: images of elliptical PNe from the Hubble Space Telescope

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We report new results from high spatial-resolution WFPC2 imaging studies of "FLIERs" and other microstructures in the planetary nebulae NGC 3242, 6826, 7009 and 7662. Most FLIERs have head-tail morphologies, with the tails pointing outward from the nucleus. Ionization gradients that decrease with distance from the nebular center are ubiquitous. These are consistent with an ionization front in neutral knots of density $\approx 10^4$ cm^{-3}.

Can neutral knots account for the properties of FLIERs? We compare two broad classes of possible explanations for FLIERs to the new images: high-speed bullets ramming through the shells of planetaries and photoevaporated gas swept by winds into head-tail shapes. Both classes of models fail basic consistency tests. Hence an entirely new conceptual paradigm is needed to account for the phenomenology of FLIERs.

Accepted by the Astronomical Journal

Preprints can be obtained by www.astro.washington.edu/balick/fliers/. Download the text (available in postscript, pdf, or Word formats) and five figures (pdf only).

Note: a pdf browser such as Acrobat Reader (free from www.adobe.com) is necessary for viewing pdf files.

The structure and dynamics of the protoplanetary nebula M1–92

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We present high-resolution ($1''$) maps of ^{13}CO J=2–1 in the protoplanetary nebula M1–92, Minkowski's Footprint, obtained with the IRAM interferometer at Plateau de Bure. We confirm the main components found in our previous works: a central disk-like condensation, a bipolar double-shell structure with axial outwards velocity increasing with the distance to the star, and two opposed features at the tips of the nebula where the maximal deprojected velocity is attained, $\sim$ 70 km s^{-1}. The major quality of the present data allows to estimate the very small width of the double-shell walls, $\sim 0.6''$ ($2\ 10^{16}$ cm), and the diameter of the central disk, $2'' - 3''$ (10^{17} cm). The whole structure is probably the remnant of the previous AGB shell, after being shocked by the bipolar post-AGB jets. The mass of the molecular envelope is about 0.9 $M_\odot$ and its kinetic momentum and energy (released by the wind interaction) are $\sim 3\ 10^{39}$ gr cm s^{-1} and $\sim 7\ 10^{45}$ erg, respectively. Since the interaction time must be significantly smaller than the age of the nebula, 900 yr, these figures imply

very energetic post-AGB jets that cannot be driven by radiation pressure.We also notice that the inner disk-like structure is too large for collimating the very narrow post-AGB jets. We propose that reaccretion of material, ejected during the previous AGB phase, is the most likely mechanism to explain the strongly bipolar and very energetic post-AGB ejections.

Accepted by Astrophys. J.

Preprints can be obtained by contacting bujarrabal@oan.es, *or from anonymous ftp on* ftp.oan.es (file: pub/preprints/m192co21.ps), *or via www on* http://www.oan.es/preprints

H_2O Ice in the Envelopes of OH/IR Stars

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In an attempt to better understand the conditions under which molecules condense onto grains in the envelopes of evolved stars, we have searched for the presence of H_2O ice in the circumstellar envelopes of several evolved (OH/IR) stars. The sample of stars observed was selected on the basis of mass-loss rates, luminosities and outflow velocities in order to cover a range of physical conditions that might affect the amount of ice present in stellar envelopes. Despite the clear presence of H_2O ice around other, previously observed, evolved stars, our search in six OH/IR stars has resulted in only one clear detection, in OH 26.5+0.6, and the tentative detection in one other, OH 26.4-1.9. We provide column densities or upper limits for the amount of ice that is present on the grains around these stars and explore the possibility that there could be a relationship between $\dot{M}_\star$ or $\dot{M}_\star / L_\star$ and the H_2O ice column density to explain the observations.

Accepted by The Astronomical Journal

Preprints can be obtained by contacting meyer@cygnus.arc.nasa.gov

Polarization Of Astronomical Maser Radiation. IV. Circular Polarization Profiles

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Profile comparison of the Stokes parameters V and I is a powerful tool for maser data analysis, providing the first direct methods for unambiguous determination of (1) the maser saturation stage, (2) the amplification optical depth and intrinsic Doppler width of unsaturated masers, and (3) the comparative magnitudes of Zeeman splitting and Doppler linewidth. Circular polarization recently detected in OH 1720 MHz emission from the Galactic center appears to provide the first direct evidence for maser saturation.

Accepted by ApJ (Sep 1, 1998)

Preprints can be obtained by contacting moshe@pa.uky.edu
or via WWW at http://xxx.lanl.gov/abs/astro-ph/9804040
or via anonymous ftp to pa.uky.edu, *directory* /moshe/MaserCircularPolarization

Dissertation abstracts

Contribution to the kinematical and dynamical study of Planetary Nebulæ in the Galaxy

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The purpose of this thesis is to bring some insights on the structure and dynamics of the Galaxy by the use of planetary nebulæ. Those tracers are transient objects of considerable astrophysical interest. They cover a great range of ages, and can be followed throughout the galaxy, thanks to their emission line spectra.

This thesis is divided into two principal parts:
The first concerns essentially the kinematical aspect of planetary nebulæ in the Galaxy. All known radial velocities are compiled in a catalog: for each planetary nebula, the final value is obtained by calculating the mean of all available radial velocities weighted by their associated uncertainties. The catalog contains 867 galactic planetary nebulæ. 90 % of the final uncertainties are lower than 20 $\mathrm{km\,s^{-1}}$. This catalog is examined in a preliminary kinematical study; the principal kinematical parameters of the galactic differential rotation are evaluated by a least-square fitting method, and the rotation curve is established.
In the second part of the thesis, we proceed to a dynamical analysis of the 673 planetary nebulæ for which radial velocities were available in 1996. The modeling consists basically in fitting a set of galactic orbits to the observed distribution of radial velocities, longitudes and latitudes of planetary nebulæ. We use for this a quadratic programming method which essentially determines the coefficients of a linear combination of (simple) functions $F_i(E, L_z)$, representing the distribution function, by minimizing a χ^2-type function constructed from the data and subject to linear constraints arising from the positivity of the distribution function. The density map at 2.2 μm of Cobe is used to overcome the biases in the data, at least in a first approximation. Once the distribution function obtained we examine the different orbital structures of planetary nebulæ. The deprojection of the galactic density map with that 2 integrals distribution function allows to derive the scale-lengths of the main galactic components (namely the thin disc, the thick disc, the bulge and the halo); for instance, we find an exponential scale-length of 2.6 kpc for the thin disk, and an index of 3.2 for the halo power-law. The projected velocity dispersions of planetary nebulæ are not well fitted by our 2 integrals model, especially in the thick disk: this can be interpreted by the presence of biaises in the stellar sample or by the presence of the third integral of motion in the distribution function.
(Thesis written in french)

Request for preprints

Two reviews will be given at the IAU Symposium in Montpellier on extra-galactic AGB stars and mass loss, with emphasis on the LMC/SMC, Sagittarius dwarf and other Galactic satellites (by Martin Groenwegen and by Albert Zijlstra). If you have something which could be of interest to these reviews, we would appreciate receiving preprints/reprints. Work in progress can also be mentioned in the reviews. If possible, two (paper) copies would be appreciated. They can be send to :

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