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Abstract of recently accepted papers

High resolution millimeter imaging of the proto-planetary nebula He 3-1475

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We report high resolution ($1''$–$2''$) imaging of the CO 2–1 line and the millimeter continuum in the proto-planetary nebula He 3-1475. The observations reveal the presence of a massive ($\sim 0.6\ M_\odot$) envelope of molecular gas around the origin of the remarkable bipolar jet system seen in optical images with the *HST*. The CO kinematics are well modeled by an expanding, bi-conical envelope: the prominent, high-velocity (~ 50 km s^{-1}) wings seen in single-dish CO spectra arise where the sides of the bi-cones are projected along the line of sight. The continuum is detected at 1.3 mm and 2.6 mm and is due to thermal emission from warm ($\sim$ 80 K) circumstellar dust. The structure, kinematics, and expansion time of the envelope provide strong evidence for entrainment of the molecular gas by the high velocity jets. The observations support an evolutionary scenario in which a period of enhanced mass loss by the central star is followed by the development of the bipolar jets which burst through the molecular envelope. The jet-envelope interactions play a crucial role in shaping the subsequent ionized nebula.

Accepted by A&A
Preprints can be obtained by contacting patrick.huggins@nyu.edu
or via WWW on www.physics.nyu.edu/~pjh1/

Physical structure of the protoplanetary nebula CRL 618. II. Interferometric mapping of millimeter-wavelength HCN (J=1–0), HCO$^+$ (J=1–0), and continuum emission

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We present interferometric maps with high angular resolution, $1.''1$ to $1.''9$, of the HCO$^+$ (J=1–0) and HCN (J=1–0) emission lines in the protoplanetary nebula CRL 618. These molecules are present in both the slowly ($\sim$10-20 km s^{-1}) and rapidly ($\sim$200 km s^{-1}) outflowing components of the molecular envelope of CRL 618. The

high-velocity (HV) molecular outflow is composed of two compact (mean size $\sim 1''$) clumps aligned with the optical lobes and separated by $2.''1$. The distance between these clumps is now $0.''5$ larger than 11 yr ago, which is consistent with rapid expansion of the HV clumps. The expansion velocity in the HV outflow increases linearly with the distance to the nebular center, from which we derive a kinematical age of ~ 60 yr. Our data reveal that part of the low velocity (LV) molecular gas in CRL 618 arises in a extended structure elongated $\sim 11''$ in the direction perpendicular to the outflow, which is consistent with a dense, equatorial torus expanding at $V_{\rm exp} \sim 17.5\,{\rm km\,s^{-1}}$. We have used a two-dimensional spatio-kinematical model to better constrain the structure, kinematics, and density distribution of the HV and LV components probed by HCN (J=1–0) and HCO^+ (J=1–0) emission. The central HII region of CRL 618, traced by free-free mm-continuum emission, is unresolved in these observations. We report *i*) a recent decrease of the mm-continuum flux and *ii*) a 3mm-to-1mm flux ratio that is consistent with optically thin free-free emission in the mm-wavelength range. The continuum flux at 3 mm (1 mm) was 1.6 ± 0.15 Jy (1.2 ± 0.3 Jy) in 2000, when our observations were performed. The weakening of the mm-continuum as well as the decrease of the free-free turnover frequency could result from a recent cessation of the post-AGB wind or the growth of the cavity of the central HII region (or both). From a consideration of multi-wavelength datasets on CRL 618 we provide a comprehensive view of the temporal evolution of its nebular material.

Accepted by Astrophysical Journal
Preprints can be obtained by contacting sanchez@astro.caltech.edu

A survey for water maser emission towards planetary nebulae. New detection in IRAS 17347-3139

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We report a water maser survey towards a sample of 27 planetary nebulae (PNe) using the Robledo de Chavela and Medicina single-dish antennas, as well as the Very Large Array (VLA). Two detections have been obtained: the already known water maser emission in K 3-35, and a new cluster of masers in IRAS 17347-3139. This low rate of detections is compatible with the short life-time of water molecules in PNe ($\sim$ 100 yr). The water maser cluster at IRAS 17347-3139 are distributed on a ellipse of size $\simeq 0.''2 \times 0.''1$, spacially associated with compact 1.3 cm continuum emission (simultaneously observed with the VLA). From archive VLA continuum data at 4.9, 8.4, and 14.9 GHz, a spectral index $\alpha = 0.76 \pm 0.03$ ($S_\nu \propto \nu^\alpha$) is derived for this radio source, which is consistent with either a partially optically thick ionized region or with an ionized wind. However, the latter scenario can be ruled out on mass-loss considerations, thus indicating that this source is probably a young PN. The spatial distribution and the radial velocities of the water masers are suggestive of a rotating and expanding maser ring, tracing the innermost regions of a torus formed at the end of the AGB phase. Given that the 1.3 cm continuum emission peak is located near one of the tips of the major axis of the ellipse of masers, we speculate on a possible binary nature of IRAS 17347-3139, where the radio continuum emission could belong to one of the components and the water masers would be associated to a companion.

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Preprints can be obtained by contacting itziar@laeff.esa.es
or via astro-ph No. 0310415

The radially expanding molecular outflow of VX Sagittarii

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We used MERLIN to observe 22-GHz H_2O maser emission from the red supergiant VX Sgr in 1994 and 1999. The masers lie in a region 300 – 400 milli-arcsec in diameter. The angular size and the velocity distribution of the masers are similar at both epochs, although the total flux density in 1999 is only half of that seen in 1994.

The maser emission is resolved into clouds of average diameter (11.5 ± 4.0) mas which we infer are ~ 300 times denser than the surrounding wind. The cloud radius is comparable to the stellar radius. We have previously found an order of magnitude variation in the size of H_2O clouds around other evolved stars of masses 1 – 20 $M_\odot$ but the average size is consistently proportional to stellar size.

43 out of 92 distinct maser clouds observed in 1994 were matched with clouds seen in 1999. The mean change in position is 10.7 milli-arcsec. The radial component of proper motion is directed away from the centre of expansion and increases with increasing angular separation. There is no significant rotational proper motion. The expansion proper motions are consistent with the maser Doppler velocities if VX Sgr is at (1.8 ± 0.5) kpc.

The maser distribution and kinematics suggest a spheroidal thick shell in which the stellar wind is undergoing radial acceleration, from 10 km s^{-1} at the inner edge of the maser shell to 20 km s^{-1} at the outer edge. We suggest a model for the asymmetric appearance of the maser shell and compare this with the magnetic field direction deduced from OH 1612 MHz maser observations [**?**]. The maser expansion velocities have doubled between 1983 [**?**] and 1994, suggesting the entire H_2O maser shell has become more effectively accelerated, on a timescale much longer than the light-crossing time for the maser shell and much shorter than the wind-crossing time.

Accepted by MNRAS
Preprints can be obtained by contacting amsr@jb.man.ac.uk

Nature of OH maser and SiO thermal emission towards carbon star: IRAS 05373−0810 (V1187 Ori)

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We present observational evidence that IRAS 05373−0810 is a genuine carbon star with an ISO SWS spectrum closely resembling that of R Scl. Modelling of the spectral energy distribution of IRAS 05373−0810 suggests that the star has luminosity of order of $8000\,L_\odot$ and loses mass at a rate of about $2–3\,10^{-7}\,M_\odot\,yr^{-1}$. The detected OH maser emission at 1612, 1665 and 1667 MHz and SiO thermal emission at 86.85 GHz towards IRAS 05373−0810 is not associated with this source. The available observations imply that these lines, typical for O–rich sources, come from the molecular cloud L 1641 in the Orion star forming region (OH) and, very likely, from the NGC 2149 molecular complex (SiO).

Accepted by Astronomy and Astrophysics
Preprints can be obtained by contacting szczerba@ncac.torun.pl

X-ray emission from the pre-planetary nebula HE3-1475

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We report the first detection of X-ray emission in a pre-planetary nebula, Hen 3-1475. Pre-planetary nebulae are rare objects in the short transition stage between the Asymptotic Giant Branch and planetary nebula evolutionary phases, and Hen 3-1475, characterised by a remarkable S-shaped chain of optical knots, is one of the most noteworthy members of this class. Observations with the Advanced CCD Imaging Spectrometer (ACIS) onboard the Chandra X-Ray observatory show the presence of compact emission coincident with the brightest optical knot in this bipolar object, which is displaced from the central star by $2''.7$ along the polar axis. Model fits to the X-ray spectrum indicate an X-ray temperature and luminosity, respectively, of $(4.3-5.7)\times10^6$ K and $(4\pm1.4)\times10^{31}$ $(\mathrm{D}/5\,\mathrm{kpc})^2$ erg s^{-1}, respectively. Our 3σ upper limit on the luminosity of compact X-ray emission from the central star in Hen 3-1475 is $\sim 5\times10^{31}$ $(\mathrm{D}/5\,\mathrm{kpc})^2$ erg s^{-1}. The detection of X-rays in Hen 3-1475 is consistent with models in which fast collimated post-AGB outflows are crucial to the shaping of planetary nebulae; we discuss such models in the context of our observations.

Accepted by Astrophysical Journal (Letters)

Preprints can be obtained by contacting Raghvendra.Sahai@jpl.nasa.gov

Ionization and its Structural Impacts on the Evolution of Planetary Nebulae

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We review our present knowledge about the formation and evolution of planetary nebulae and evaluate the relative importance of photoionization and wind interaction. It turns out that heating by photoionization drives the expansion of a planetary nebula during its entire life, while wind interaction accelerates and shapes the inner regions only during the later stages of evolution. We found observational evidence that the transition from spherical AGB-wind structures to more aspherical ones must occur when the star begins to evolve slowly off the AGB.

To appear in "Asymmetrical Planetary Nebulae III", eds. M. Meixner, J. Kastner, N. Soker, & B. Balick (ASP Conf. Series)

Preprints can be obtained by contacting DeSchoenberner@aip.de
or via WWW on http://www.aip.de/groups/sternphysik/stp/publications_neu.html

3D AMR Simulations of Point-Symmetric Nebulae

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At the end of their lives low mass stars such as our Sun lose most of their mass. The resulting planetary nebulae show a wide variety of shapes, from spherical to highly bipolar. According to the generalized interacting stellar winds model, these shapes are due to an interaction between a very fast tenuous outflow, and a denser environment left over from an earlier slow phase of mass loss. Previous analytical and numerical work shows that this mechanism can explain cylindrically symmetric nebulae very well. However, many circumstellar nebulae have a multipolar or point-symmetric shape. With two-dimensional calculations, Icke showed that these seemingly enigmatic forms can be easily reproduced by a two-wind model in which the confining disk is warped, as is expected to occur in irradiated disks. Here, we present the extension to fully three-dimensional adaptive mesh refinement simulations of such an interaction.

Accepted by Adaptive Mesh Refinement - Theory and Applications", eds. T. Plewa, T. Linde and V.G. Weirs.

Preprints can be obtained by contacting rijkhors@strw.leidenuniv.nl
movies can be found at http://www.strw.leidenuniv.nl/AstroHydro3D/movies/

Announcement

ESO Workshop on
Planetary Nebulae beyond the Milky Way
ESO Headquarters, Garching, May 19-21, 2004

Planetary nebulae (PN) can be detected out to quite large distances from their strong emission lines, principally of [O III]. Photometry of the [O III]5007A emission line allows distance determination through the Planetary Nebula Luminosity Function. Spectrophotometry of the emission lines can provide nebular abundances, enabling the use of PN as chemical probes of galaxies. The emission lines are also narrow, making PN ideal kinematic probes of a galaxy's gravitational potential. Thus the properties of dark-matter haloes can be studied by modelling the PN kinematics. Recently PN have been detected in intra-cluster regions of nearby galaxy clusters. These PN can bring a unique handle on the stars in regions that may harbour a substantial amount of mass.

Extra-galactic PN serve as versatile probes of nearby galaxies. Planetary nebulae have traditionally been regarded as bright objects; however in the Local Group, and beyond, they can be faint. Large telescopes thus open up the field of extra-galactic PN study. HST and Adaptive Optics can provide images of PN in the LMC and SMC, at resolutions previously expected for Milky Way PN. New instrumentation is also being exploited to measure PN spectra in bulk. The field of extra-galactic PN research is developing rapidly and a conference to review the progress so far and to chart new developments is now timely.

This will be the first full workshop dedicated to the subject of extra-galactic planetary nebulae.

The format of the meeting will consist of invited reviews, in the key areas of extra-galactic PN research, contributed talks and posters, and two discussion sessions. Central topics will include (with invited speakers in brackets):

- Historical overview (M. Barlow)
- Surveys for extra-galactic PN (R. Corradi, R. Mendez, J. Feldmeier)
- The PN luminosity function (R. Ciadullo)
- PN in the Magellanic Clouds (G. Jacoby, L. Stanghellini, E. Villaver)
- Observational dynamics of PN in galaxies (N. Douglas, E. Peng)
- Modelling dark matter with PN dynamical data (O. Gerhard)
- Status of abundance determinations in PN (X.-W. Liu)
- Dependence of PN evolution on environment (C. Charbonnel)
- PN and Asymptotic Giant Branch stars in galaxies (L. Willson, M. Groenewegen)
- PN as probes of chemical evolution and star formation history (M. Richer)
- Observations of PN in intra-cluster environment of galaxy clusters (M. Arnaboldi)
- Workshop Summary (H. Ford)

Scientific Organising Committee:
M. Arnaboldi, R. Ciardullo, N. Douglas, K. Freeman, G. Jacoby, R. Mendez, R. Shaw, L. Stanghellini (co-Chair), G. Stasinska, J. Walsh (co-Chair)

Full details, list of invited speakers and registration information can be retrieved from: http://www.eso.org/extgalpn04/ or by by email to: pnconf04@eso.org

Deadline for first registration: 31 January 2004
Final deadline: 15 April 2004