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Abstract of recently accepted papers

The Enigmatic X-ray Point Sources at the Central Stars of NGC 6543 and NGC 7293

Martín A. Guerrero[1], You-Hua Chu[1], Robert A. Gruendl[1], Rosa M. Williams[2,3], and James B. Kaler[1]

[1] Astronomy Department, University of Illinois, 1002 W. Green Street, Urbana, IL 61801, USA

[2] National Research Council Associate

[3] NASA's GSFC, code 662, Greenbelt, MD 20771, USA

Recent *Chandra* ACIS-S observations have detected a point source at the central star of NGC 6543 and confirmed the point source nature of the hard X-ray emission from NGC 7293. The X-ray spectra of both sources peak between 0.5 keV and 1.0 keV and show line features indicating a thin plasma at temperatures of a few times 10^6 K. Their X-ray luminosities are 10^{30} erg s^{-1} and 3×10^{29} erg s^{-1}, respectively. We have considered four different mechanisms to explain the nature of these sources. The X-ray emission from the central star of NGC 6543 may originate from the coronal activity of an undetected companion star or from shocks in its fast stellar wind, while the hard X-ray emission from NGC 7293 might be ascribed to an undetected dMe companion. Follow-up observations are needed to determine the existence and natures of these stellar companions.

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http://www.uiuc.edu/~mar/preprint.Xhelix.ps or http://xxx.lanl.gov/abs/astro-ph/0104270

Variable Hα Line Emission from the Central Star of the Helix Nebula

Robert A. Gruendl[1], You-Hua Chu[1], Ian J. O'Dwyer[1], and Martín A. Guerrero[1]

[1] Astronomy Department, University of Illinois, 1002 W. Green Street, Urbana, IL 61801, USA

The central star of the Helix Nebula is a hot white dwarf with unexpected hard X-ray emission. With an effective temperature of ~100,000 K, the star is a powerful source of H-ionizing radiation; the atmosphere of a stellar or planetary companion, if present, will be ionized and emit recombination lines. To probe the origin of hard X-ray emission from the Helix Nebula's central star, we have obtained multi-epoch high-dispersion spectra of the star, and found temporal variation in the Hα line profile over a time span of one week. The observed width and strength of the variable Hα emission component are consistent with the hypothesized dMe companion proposed to explain the hard X-ray emission. A dMe companion, however, cannot explain the

possible detection of variable He II and [N II] emission. Follow-up spectroscopic monitoring of the Helix Nebula central star is needed to better establish the identification of the spectral lines and their temporal behavior in order to determine the origin of the optical variability and hard X-ray emission.

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Dust-enshrouded Asymptotic Giant Branch Stars in the Solar Neighbourhood

Enrico Olivier [1], *Patricia Whitelock* [2] *and Fred Marang* [2]

[1]Research School of Astronomy and Astrophysics, Private Bag, Weston Creek PO, Canberra, ACT, 2611, Australia.

[2]South African Astronomical Observatory, PO Box 9, 7935 Observatory, South Africa

A study is made of a sample of 58 dust-enshrouded Asymptotic Giant Branch (AGB) stars (including 2 possible post AGB stars), of which 27 are carbon-rich and 31 are oxygen-rich. These objects were originally identified by Jura & Kleinmann as nearby (within about 1 kpc of the sun) AGB stars with high mass-loss rates ($\dot{M} > 10^{-6}\, M_{\odot} yr^{-1}$). Ground-based near-infrared photometry, data obtained by the IRAS satellite and kinematic data (radial and outflow velocities) from the literature are combined to investigate the properties of these stars. The light amplitude in the near-infrared is found to be correlated with period, and this amplitude decreases with increasing wavelength. Statistical tests show that there is no reason to suspect any difference in the period distributions of the carbon- and oxygen-rich stars for periods less than 1000 days. There are no carbon-rich stars with periods longer than 1000 days in the sample. The colours are consistent with those of cool stars with evolved circumstellar dust-shells. Luminosities and distances are estimated using a period-luminosity relation. Mass-loss rates, estimated from the 60 μm fluxes, show a correlation with various infrared colours and pulsation period. The mass-loss rate is tightly correlated with the $K-[12]$ colour. The kinematics and scale-height of the sample shows that the sources with periods less than 1000 days must have low mass main-sequence progenitors. It is argued that the three oxygen-rich stars with periods over 1000 days probably had intermediate mass main-sequence progenitors. For the other stars an average progenitor mass of about 1.3 $M_{\odot}$ is estimated with a final white dwarf mass of 0.6 $M_{\odot}$. The average lifetime of stars in this high mass-loss AGB phase is estimated to be about 4×10^4 years, which suggests that these stars will undergo at most one more thermal pulse before leaving the AGB if current theoretical relations between thermal interpulse-period and core-mass are correct.

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Optical spectra of three AGB stars

V. Klochkova[1], *G. Zhao*[2], *V. Panchuk*[1], *N. Tavolganskaya*[1]

[1] – Special Astrophysical Observatory, N. Arkhyz, 369167 Russia

[2] – Beijing Astronomical Observatory, Beijing, 100012, P. R. China

Based on CCD–spectra obtained with echelle-spectrometers of the 6–m telescope, we have determined fundamental parameters and detailed chemical composition of the three asymptotic giants branch stars with close values of effective temperature and surface gravity.

For the first time the metallicity and chemical composition of optical counterpart of the OH/IR–star IRAS 18123 + 0511 are determined. Average abundance of iron group elements (V, Cr, Fe) is equal to $[X/H]_{\odot} = -0.45$ dex. High overabundance of oxygen $[O/Fe]_{\odot} = 1.44$dex is revealed in the atmosphere of the star. Abundances of the s–process heavy elements are not increased, they are rather decreased relative to the metallicity: the average value for Y, Zr, Ba, La, Ce, Pr, Nd is equal to $[X/Fe]_{\odot} = -0.25$. Chemical elements abundance pattern in whole confirms the AGB evolution stage for the the object IRAS 18123 + 0511. The metallicity in combination

with the radial velocity $V_r = 78.0\,km/sec$ and galactic latitude $|b| = 11^o$ indicate belonging of the object to the old disc population. The expansion velocity of the circumstellar envelope $V_{exp} \approx 21\,km/sec$ is found from positions of absorbtions forming in the envelope.

Parameters obtained for the metal deficient high latitude supergiants BD $+18^o\,2757$ and BD $+18^o\,2890$ (iron content $[Fe/H]_\odot = -2.10$ and -1.48, respectively) confirm their belonging to evolved halo stars, maybe, to UU Her type stars.

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Preprints can be obtained by contacting valenta@sao.ru

Evolution of the dust mass loss with luminosity along the giant branch of the globular cluster 47 Tuc

A. Ramdani[1,2] *and A. Jorissen*[2]

[1] Département de Physique, Université d'Oujda, Maroc

[2] Institut d'Astronomie et d'Astrophysique, Université Libre de Bruxelles, C.P. 226, Boulevard du Triomphe, B-1050 Bruxelles, Belgium

The present paper investigates the properties of the dust mass loss in stars populating the giant branch of the globular cluster 47 Tuc, by combining ISOCAM and DENIS data. Raster maps of 5 fields covering areas ranging from 4×4 to $15 \times 15\,\mathrm{arcmin}^2$ at different distances from the center of the cluster have been obtained with ISOCAM at $11.5\,\mu$m (LW10 filter). The covered fields include most of the red variables known in this cluster. A detection threshold of about 0.2 mJy is achieved, allowing to detect giant stars at $11.5\,\mu$m all the way down to the horizontal branch. No dust-enshrouded asymptotic giant branch stars have been found in the observed fields, contrary to the situation encountered in LMC/SMC globular clusters with larger turnoff masses.
The color index $[12]-[2]$ (based on the ISO 11.5 μm flux and on the DENIS K_s magnitude) is used as a diagnostic of dust emission (and hence dust mass loss). Its evolution with luminosity along the giant branch reveals that dust mass loss is only present in V3 (the only cluster Mira variable observed in the present study) and in V18, a star presenting intermittent variability. This conclusion confirms the importance of stellar pulsations in the dust formation and ensuing mass loss.

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or on http://arXiv.org/abs/astro-ph/0105021

Sub-arcsecond Mid-IR Structure of the Dust Shell around IRAS 22272+5435

Toshiya Ueta[1], *Margaret Meixner*[1], *Philip M. Hinz*[2], *William F. Hoffmann*[2], *Wolfgang Brandner*[3], *Aditya Dayal*[4], *Lynne K. Deutsch*[5], *Giovanni G. Fazio*[6], *and Joseph L. Hora*[6]

[1] Dept. of Astronomy, Univ. of Illinois at Urbana-Champaign, MC-221, Urbana, IL 61801, USA (ueta@astro.uiuc.edu, meixner@astro.uiuc.edu)

[2] Steward Observatory, Univ. of Arizona, Tucson, AZ 85721, USA (phinz@as.arizona.edu, whoffmann@as.arizona.edu)

[3] Institute for Astronomy, Univ. of Hawaii, 2680 Woodlawn Drive, Honolulu, HI 96822, USA (brandner@ifa.hawaii.edu)

[4] KLA-Tencor Corp., 160 Rio Robles, San Jose, CA 95134, USA (Aditya.Dayal@kla-tencor.com)

[5] Dept. of Astronomy/CAS 519, Boston University, 725 Commonwealth Avenue, Boston, MA 02215, USA (deutschl@bu.edu)

[6] Harvard-Smithsonian Center for Astrophysics, MS 65, 60 Garden St., Cambridge, MA 02138, USA (jhora@cfa.harvard.edu, gfazio@cfa.harvard.edu)

We report sub-arcsecond imaging of extended mid-infrared emission from a proto-planetary nebula (PPN), IRAS 22272+5435, performed at the MMT observatory with its newly upgraded 6.5 m aperture telescope and at the Keck observatory. The mid-infrared emission structure is resolved into two emission peaks separated by 0.5" – 0.6" in the MMT 11.7 μm image and in the Keck 7.9, 9.7, and 12.5 μm images, corroborating the predictions based on previous multi-wavelength morphological studies and radiative transfer calculations. The resolved images show that the PPN dust shell has a toroidal structure with the 0.5" inner radius. In addition, an unresolved mid-IR excess appears at the nebula center. Radiative transfer model calculations suggest that the highly equatorially-enhanced ($\rho_{\rm eq}/\rho_{\rm pole} = 9$) structure of the PPN shell was generated by an axisymmetric superwind with $\dot{M}_{\rm sw} = 4 \times 10^{-6} M_\odot$ yr^{-1}, which was preceded by a spherical asymptotic giant branch (AGB) wind with $\dot{M}_{\rm AGB} = 8 \times 10^{-7} M_\odot$ yr^{-1}. These model calculations also indicate that the superwind shell contains larger dust grains than the AGB wind shell. The unresolved mid-infrared excess may have been produced by a post-AGB mass loss at a rate of $2 - 6 \times 10^{-7} M_\odot$ yr^{-1}. While the central star left the AGB about 380 years ago after the termination of the superwind, the star seems to have been experiencing an ambient post-AGB mass loss with a sudden, increased mass ejection about 10 years ago.

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High Resolution Images of CO J=2-1 Emission from the Carbon Star V Cyg

J.H. Bieging[1] *and C.D. Wilson*[2]

[1] Steward Observatory, The University of Arizona, Tucson AZ 85721 USA

[2] Dept. of Physics and Astronomy, McMaster University, Hamilton ON L8S 4M1 Canada

This paper presents observations of the CO J=2–1 emission from the circumstellar envelope of the mass-losing carbon star V Cyg. The observations were made with the Caltech Millimeter Array. A previously published single-dish map was used to construct short-spacing visibilities not sampled by the interferometer data, thereby recovering missing flux in extended low-brightness emission. The images have an angular resolution of $\sim$ 1.2 arcsec with velocity resolution of 1 MHz (1.3 km s^{-1}). The channel maps are consistent with an expanding envelope which is roughly spherical, but they also show evidence for asymmetric structure as well as small-scale clumping.

We compare these observations, as well as other published spectra, with statistical equilibrium models for CO in a circumstellar envelope. Models which fit the spherically averaged data must invoke a mass loss rate, $\dot{M}$, which has decreased with time by a factor of $\sim 2-3$ over the past several hundred years. The model kinetic temperature structure in radius, $T_K(r)$, decreases as $r^{-0.8}$ out to $r \approx 6 \times 10^{15}$ cm and levels off to a constant value at T_K = 23 K beyond. The secular change in $\dot{M}$ may be related to changes in the stellar luminosity or temperature as predicted by recent numerical hydrodynamic models for mass loss. The inferred kinetic

temperature structure suggests that heating by the photoelectric effect on dust grains is important in the outer envelope.

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Preprints can be obtained by contacting jbieging@as.arizona.edu

FLIERs as stagnation knots from post-AGB winds with polar momentum deficiency

W. Steffen[1], *J.A. López*[2] *and A. Lim*[3]

[1] Instituto de Astronomía y Meteorología, Universidad de Guadalajara, Av. Vallarta 2602, 44130 Guadalajara, Jal., México

[2] Instituto de Astronomía, Universidad Nacional Autónoma de México, Apartado Postal 877, 22800 Ensenada, B.C., México

[3] Department of Physics and Astronomy, University College London, Gower Street, London WC1E 6BT, UK

We present an alternative model for the formation of fast low-ionization emission regions (FLIERs) in planetary nebulae that is able to account for many of their attendant characteristics and circumvent the problems on the collimation/formation mechanisms found in previous studies. In this model, the section of the stellar wind flowing along the symmetry axis carries less mechanical momentum than at higher latitudes, and temporarily develops a concave or inverted shock geometry. The shocked ambient material is thus refracted towards the symmetry axis, instead of away from it, and accumulates in the concave section. The reverse is true for the outflowing stellar wind, which in the reverse shock is refracted away from the axis. It surrounds the stagnation region of the bow-shock and confines the trapped ambient gas. The latter has time to cool and is then compressed into a dense "stagnation knot" or "stagnation jet". In the presence of a variable stellar wind these features may eventually overrun the expanding nebular shell and appear as detached FLIERs. We present representative two and three-dimensional hydrodynamic simulations of the formation and early evolution of stagnation knots and jets and compare their dynamical properties with those of FLIERs in planetary nebulae.

Subject Headings: hydrodynamics - ISM: jets and outflows - ISM: kinematics and dynamics - planetary nebulae: FLIERs and stagnation knots

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WWW *or via WWW on* http://xxx.lanl.gov/abs/astro-ph/0104060

8–13μm Dust Emission Features in Galactic Bulge Planetary Nebulae

S. Casassus[1,2], *P. F. Roche*[1], *D. K. Aitken*[3] *& C. H. Smith*[4]

[1] Astrophysics, Physics Department, Oxford University, Keble Road, Oxford OX1 3RH

[2] Departamento de Astronomía, Universidad de Chile, Casilla 36-D, Santiago, Chile.

[3] Department of Physical Sciences, University of Hertfordshire, Hatfield, Herts AL10 9AB

[4] School of Physics, University College, UNSW, Canberra, ACT 2600, Australia.

A sample of 25 IR-bright planetary nebulae (PNe) towards the Galactic bulge is analysed through 8–13μm spectroscopy. The classification of the warm-dust emission features provides a measure of the C/O chemical balance, and represents the first C/O estimates for bulge PNe. Out of 13 PNe with identified dust types, 4 PNe have emission features associated with C-based grains, while the remaining 9 have O-rich dust signatures. The low fraction of C-rich PNe, $\lesssim$30%, contrasts with that for local PNe, around $\sim$80%, although it follows the trend for a decreasing frequency of C-rich PNe with galactocentric radius (paper I). We investigate whether the PNe discussed here are linked to the bulge stellar population (similar to type IV, or halo, PNe) or the

inner Galactic disk (a young and super-metal-rich population). Although 60% of the PNe with warm dust are convincing bulge members, none of the C-rich PNe satisfy our criteria, and they are probably linked to the inner Galactic disk. In the framework of single star evolution, the available information on bulge PNe points towards a progenitor population similar in age to that of local PNe (type I PNe are found in similar proportions), but super-metal-rich (to account for the scarcity of C-rich objects). Yet the metallicities of bulge PNe, as inferred from [O/H], fail to reach the required values - except for the C-rich objects. It is likely that the sample discussed here is derived from a mixed disk/bulge progenitor population and dominated by type IV PNe, as suggested by Peimbert (1992). The much higher fraction of O-rich PNe in this sample than in the solar neighbourhood should result in a proportionally greater injection of silicate grains into the inner Galactic medium.

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Preprints can be obtained by contacting simon@das.uchile.cl, pfr@astro.ox.ac.uk
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The evolutionary time scale of Sakurai's object: A test of convection theory?

Falk Herwig
University of Victoria, B.C., Box 3055, V8W 3P6, Canada

Sakurai's object (V4334 Sgr) is a born again AGB star following a *very late thermal pulse*. So far no stellar evolution models have been able to explain the extremely fast evolution of this star, which has taken it from the pre-white dwarf stage to its current appearance as a giant within only a few years. A very high stellar mass can be ruled out as the cause of the fast evolution. Instead the evolution time scale is reproduced in stellar models by making the assumption that the efficiency for element mixing in the He-flash convection zone during the very late thermal pulse is smaller than predicted by the mixing-length theory. As a result the main energy generation from fast proton capture occurs closer to the surface and the expansion to the giant state is accelerated to a few years. Assuming a mass of V4334 Sgr of 0.604 $M_{\odot}$ – which is consistent with a distance of 4 kpc – a reduction of the mixing length theory mixing efficiency by a factor of ~ 100 is required to match its evolutionary time scale. This value decreases if V4334 Sgr has a smaller mass and accordingly a smaller distance. However, the effect does not disappear for the smallest possible masses. These findings may present a semi-empirical constraint on the element mixing in convective zones of the stellar interior.

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