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Editors: Jacco van Loon and Albert Zijlstra

Editorial

Dear Colleagues,

It is our pleasure to present you the 120$^{\rm th}$ issue of the AGB Newsletter. Apart from a selection of very nice recent papers, please note the release of an extensive database of circumstellar hydroxyl masers at the end of the newsletter.

It is not (yet) too late to register for the RS Ophiuchi workshop (12-14 June 2007): http://www.astro.keele.ac.uk/rsoph

Last month's *Food for Thought* statement, "Which are the evaporating planets in images of Planetary Nebulae?" evoked an interesting reaction from Noam Soker, who would like to point out his 1999 paper "Detecting planets in planetary nebulae" (MNRAS, 306, 806). The abstract of that paper mentions "The interaction of the radiation and wind with a planet may lead to the formation of a compact condensation or tail inside the PN, which emits strongly in Hα, but not in [O III]. The position of the condensation (or tail) will change over a time-scale of ~ 10 yr. Such condensations might be detected with currently existing telescopes." Therefore, Noam suggests to compare fine structures bright in Hα but not in [O III] (because the material is too dense for forbidden lines) over a period of several years, and look for orbital motion of such structures. These will be extremely close to the central star, and will require the best telescopes.

Noam Soker also suggests to look for *stars* inside PNe. These will be easier to detect, and at wider separations. This is suggested in his 1996 paper "Stellar bubbles inside planetary nebulae" (MNRAS, 283, 1405): "Such bubbles are likely to be formed by very wide binary companions to the progenitors of planetary nebulae [..] The bubbles are likely to appear as bright, low-ionization small ($10^{15} - 10^{17}$ cm) areas in images of planetary nebulae." Noam suggested there an orbital separation of > 1000 AU, but notes that at even smaller separations one should see such bubbles formed by the wind of the companion (assumed to be a low mass main sequence star). Noam estimates that, if one were to take high quality data of tens of PNe, one would expect signatures (one bubble inside the PN) of stellar companions at wide separations (wide enough for the stellar companion not to influence the main shaping process) in at least a few of these.

The next issue will be distributed on the 1$^{\rm st}$ of June; the deadline for contributions is the 31$^{\rm st}$ of May.

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

Where are the bubbles predicted to exist within some Planetary Nebulae?

Reactions to this statement or suggestions for next month's statement can be e-mailed to agbnews@astro.keele.ac.uk (please state whether you wish to remain anonymous)

Refereed Journal Papers

Evidence for deuterium astration in the planetary nebula Sh 2–216?

Cristina M. Oliveira[1], *Pierre Chayer*[1,2], *H. Warren Moos*[1], *Jeffrey W. Kruk*[1] *and Thomas Rauch*[3]

[1]Johns Hopkins University, USA
[2]University of Victoria, Canada
[3]Universität Tübingen, Germany

We present *FUSE* observations of the line of sight to WD 0439+466 (LS V +46 21), the central star of the old planetary nebula Sh 2–216. The *FUSE* data shows absorption by many interstellar and stellar lines, in particular D I, H_2 ($J = 0$ – 9), HD $J = 0 - 1$, and CO. Many other stellar and ISM lines are detected in the STIS E140M *HST* spectra of this sightline, which we use to determine N(H I). We derive, for the neutral gas, D/H = $(0.76 \pm^{0.12}_{0.11})\times10^{-5}$, O/H = $(0.89 \pm^{0.15}_{0.11})\times10^{-4}$ and N/H = $(3.24 \pm^{0.61}_{0.55})\times10^{-5}$. We argue that most of the gas along this sightline is associated with the planetary nebula. The low D/H ratio is likely the result of this gas being processed through the star (astrated) but not mixed with the ISM. This would be the first time that the D/H ratio has been measured in predominantly astrated gas. The O/H and N/H ratios derived here are lower than typical values measured in other planetary nebulae likely due to unaccounted for ionization corrections.

Accepted for publication in ApJL
Available from arXiv:0703703

The Kinematics of Intracluster Planetary Nebulae and the On-Going Subcluster Merger in the Coma Cluster Core

Ortwin Gerhard[1], *Magda Arnaboldi*[2,3], *Kenneth C. Freeman*[4], *Sadanori Okamura*[5], *Nobunari Kashikawa*[6] *and Naoki Yasuda*[7]

[1]Max-Planck-Institut für Ex. Physik, Garching, Germany
[2]ESO, Garching, Germany
[3]INAF, Oss. Astr. di Torino, Italy
[4]RSAA, Mt Stromlo Observatory, Australia
[5]Dept. of Astronomy and RESCEU, Univ. of Tokyo, Japan
[6]NAOJ, Tokyo, Japan
[7]Institute for Cosmic Ray Research, Univ. of Tokyo, Japan

The Coma cluster is the richest and most compact of the nearby clusters, yet there is growing evidence that its formation is still on-going. A sensitive probe of this evolution is the dynamics of intracluster stars, which are unbound from galaxies while the cluster forms, according to cosmological simulations. With a new multi-slit imaging spectroscopy technique pioneered at the 8.2 m Subaru telescope and FOCAS, we have detected and measured the line-of-sight velocities of 37 intracluster planetary nebulae associated with the diffuse stellar population of stars in the Coma cluster core, at 100 Mpc distance. We detect clear velocity substructures within a 6 arcmin diameter field. A substructure is present at ~ 5000 km s^{-1}, probably from in-fall of a galaxy group, while the main intracluster stellar component is centered around ~ 6500 km s^{-1}, ~ 700 km s^{-1} offset from the nearby cD galaxy NGC 4874. The kinematics and morphology of the intracluster stars show that the cluster core is in a highly dynamically evolving state. In combination with galaxy redshift and X-ray data this argues strongly that the cluster is currently in the midst of a subcluster merger, where the NGC 4874 subcluster core may still be self-bound, while the NGC 4889 subcluster core has probably dissolved. The NGC 4889 subcluster is likely to have fallen into Coma from the eastern A2199 filament, in a direction nearly in the plane of the sky, meeting the NGC 4874 subcluster arriving from the west. The two inner subcluster cores are presently beyond their first and second close passage, during which the elongated distribution of diffuse light has been created. We predict the kinematic signature expected in this scenario, and argue

that the extended western X-ray arc recently discovered traces the arc shock generated by the collision between the two subcluster gas halos. Any preexisting cooling core region would have been heated by the subcluster collision.

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Available from arXiv:0703770

White dwarf masses derived from planetary nebula modelling

K. Gesicki[1] *and A. Zijlstra*[2]

[1]Centrum Astronomii UMK, Torun, Poland
[2]University of Manchester, UK

We compare the mass distribution of central stars of planetary nebulae (CSPNe) with those of their progeny, white dwarfs (WD). We use a dynamical method to measure masses with an uncertainty of $0.02\,M_\odot$. The CSPN mass distribution is sharply peaked at $0.61\,M_\odot$. The WD distribution peaks at lower masses ($0.58\,M_\odot$) and shows a much broader range of masses. Some of the difference can be explained if the early post-AGB evolution is faster than predicted by the Blöcker tracks. Between 30 and 50 per cent of WD may avoid the PN phase because they have too low a mass. However, the discrepancy cannot be fully resolved and WD mass distributions may have been broadened by observational or model uncertainties.

Accepted for publication in A&A Letters
Available from arXiv:0704.0620

Multi-spectral Observations of Lunar Occultations: I. Resolving The Dust Shell Around AFGL 5440

Paul M. Harvey[1] *and Andrew Oldag*[1]

[1]Astronomy Dept., Univ. of Texas, USA

We present observations and modeling of a lunar occultation of the dust-enshrouded carbon star AFGL 5440. The observations were made over a continuous range of wavelengths from $1 - 4$ μm with a high-speed spectrophotometer designed expressly for this purpose. We find that the occultation fringes cannot be fit by any single-size model. We use the DUSTY radiative transfer code to model a circumstellar shell and fit both the observed occultation light curves and the spectral energy distribution described in the literature. We find a strong constraint on the inner radius of the dust shell, $T_{\rm max} = 950 \pm 50$ K, and optical depth at 5 μm of 0.5 ± 0.1. The observations are best fit by models with a density gradient of r^{-2} or the gradient derived by Ivezić & Elitzur for a radiatively driven hydrodynamic outflow. Our models cannot fit the observed IRAS 60 μm flux without assuming a substantial abundance of graphite or by assuming a substantially higher mass-loss rate in the past.

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Optical spectrum of the post-AGB star HD 56126 in the region 4010-8790 Å.

V.G.Klochkova[1]*, E.L.Chentsov*[1]*, N.S.Tavolganskaya*[1] *and M.V.Shapovalov*[2]

[1]Special Astrophysical Observatory, N.Arkhyz, Russia
[2]Rostov State University, Rostov-on-Don, Russia

We studied in detail the optical spectrum of the post-AGB star HD 56126 associated with the IR-source IRAS 07134+1005. We use high resolution spectra ($R = 60000$ and 25000) obtained with the echelle spectrographs of the 6-m telescope.

About one and a half thousand absorptions of neutral atoms and ions, absorption bands of C_2, CN, and CH molecules, and interstellar bands (DIBs) are identified in the 4010 to 8790 Å wavelength region, and the depths and radial velocities of these spectral features are measured. Differences are revealed between the variations of the radial velocities measured from spectral features of different excitation. In addition to the well-known variability of the Hα profile, we found variations in the profiles of a number of Fe II, Y II, and Ba II lines. We also produce an atlas of the spectrum of HD 56126 and its comparison star α Per. The full version of the atlas is available in electronic form from: http://www.sao.ru/hq/ssl/Atlas/Atlas.html.

Accepted for publication in Astrophysical Bulletin, 2007, vol.62
Available from arXiv:0704.0677
and from http://www.sao.ru/hq/ssl/Atlas/Atlas.html

Mapping the circumstellar SiO maser emission in R Leo

R. Soria-Ruiz[1], *J. Alcolea*[2], *F. Colomer*[3], *V. Bujarrabal*[3] *and J.-F. Desmurs*[2]

[1]Joins Institute for VLBI in Europe, Postbus 2, 7990 AA Dwingeloo, The Netherlands
[2]Observatorio Astronómico Nacional, Alfonso XII 3, E-28014 Madrid, Spain
[3]Observatorio Astronómico Nacional, Apartado 112, E-28803 Alcalá de Henares, Spain

The study of the innermost circumstellar layers around AGB stars is crucial to understand how these envelopes are formed and evolve. The SiO maser emission occurs at a few stellar radii from the central star, providing direct information on the stellar pulsation and on the chemical and physical properties of these regions. Our data also shed light on several aspects of the SiO maser pumping theory that are not well understood yet. We aim to determine the relative spatial distribution of the 43 GHz and 86 GHz SiO maser lines in the oxygen-rich evolved star R Leo. We have imaged with milliarcsecond resolution, by means of Very Long Baseline Interferometry, the 43 GHz (^{28}SiO v=1, 2 J=1-0 and ^{29}SiO v=0 J=1-0 and 86 GHz (^{28}SiO v=1 J=2-1 and ^{29}SiO v=0 J=2-1) masing regions. We confirm previous results obtained in other oxygen-rich envelopes. In particular, when comparing the 43 GHz emitting regions, the ^{28}SiO v=2 J=1-0 transition is produced in an inner layer, slightly closer to the central star than the v=1 J=1-0. On the other hand, the 86 GHz ^{28}SiO v=1 J=2-1 line arises in a clearly farther shell. We have also mapped for the first time the ^{29}SiO v=0 J=1-0 emission in R Leo. The already reported discrepancy between the observed distributions of the different maser lines and the theoretical predictions is also found in R Leo.

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Identification of PN G232.0+05.7 as a new halo planetary nebula and of IRAS 19336−0400 as a new type III planetary nebula

C. B. Pereira[1] *and L. F. Miranda*[2]

[1]Observatório Nacional - Rio de Janeiro - Brazil
[2]Instituto de Astrofísica de Andalucía - Granada - Spain

Aims : We determined the nature and Peimbert type of two low-excitation planetary nebulae, PNG 232.0+05.7 and IRAS 19336−0400.
Methods : We used low resolution optical spectroscopy in the range 3200-9000 Å.
Results : We derived line intensities, reddening, hysical conditions (electron density and temperature) and ionic and elemental abundances. Based on the abundance analysis and its radial velocity we conclude that PNG 232.0+05.7 is a halo planetary nebulae. This discovery thus adds this object to the sample of ten known halo planetary nebulae. IRAS 19336−0400 is probably a type III planetary nebulae, as strongly suggested by its abundances and high radial velocity, although this conclusion awaits a better estimation of its distance.

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Externally-polluted white dwarfs with dust disks

M. Jura[1], *J. Farihi*[2] *and B. Zuckerman*[1]

[1]UCLA, USA

[2]Gemini Observatory, USA

We report Spitzer Space Telescope photometry of eleven externally-polluted white dwarfs. Of the nine stars for which we have IRAC photometry, we find that GD 40, GD 133 and PG 1015+161 each has an infrared excess that can be understood as arising from a flat, opaque, dusty disk. GD 56 also has an infrared excess characteristic of circumstellar dust, but a flat-disk model cannot reproduce the data unless there are grains as warm as 1700 K and perhaps not even then. Our data support the previous suggestion that the metals in the atmosphere of GD 40 are the result of accretion of a tidally-disrupted asteroid with a chondritic composition.

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Infrared High-Resolution Spectroscopy of Post-AGB Circumstellar Disks. I. HR 4049 - The Winnowing Flow Observed?

Kenneth H. Hinkle[1], *Sean D. Brittain*[2] *and David L. Lambert*[3]

[1]National Optical Astronomy Observatory, USA

[2]Clemson University, USA

[3]The W.J. McDonald Observatory, USA

High-resolution infrared spectroscopy in the 2.3-4.6 μm region is reported for the peculiar A supergiant, single-lined spectroscopic binary HR 4049. Lines from the CO fundamental and first overtone, OH fundamental, and several H_2O vibration-rotation transitions have been observed in the near-infrared spectrum. The spectrum of HR 4049 appears principally in emission through the 3 and 4.6 μm region and in absorption in the 2 μm region.The 4.6 μm spectrum shows a rich 'forest' of emission lines. All the spectral lines observed in the 2.3-4.6 μm spectrum are shown to be circumbinary in origin. The presence of OH and H_2O lines confirm the oxygen-rich nature of the circumbinary gas which is in contrast to the previously detected carbon-rich material. The emission and absorption line profiles show that the circumbinary gas is located in a thin, rotating layer near the dust disk. The properties of the dust and gas circumbinary disk and the spectroscopic orbit yield masses for the individual stars, $M_{\rm AI} \sim 0.58$ $M_\odot$ and $M_{\rm MV} \sim 0.34$ $M_\odot$. Gas in the disk also has an outward flow with a velocityof $\gtrsim 1$ km s^{-1}. The severe depletion of refractory elements but near-solar abundances of volatile elements observed in HR 4049 results from abundance winnowing. The separation of the volatiles from the grains in the disk and the subsequent accretion by the star are discussed. Contrary to prior reports, the HR 4049 carbon and oxygen isotopic abundances are typical AGB values: $^{12}C/^{13}C=6^{+9}_{-4}$ and $^{16}O/^{17}O> 200$.

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Abundances in intermediate-mass AGB stars undergoing third dredge-up and hot-bottom burning

J.A. McSaveney[1,2], *P.R. Wood*[1], *M. Scholz*[3], *J.C. Lattanzio*[2] *and K.H. Hinkle*[4]

[1]RSAA, ANU, Australia

[2]CSPA, Monash, Australia

[3]Inst. Theor. Ap., Heidelberg, Germany

[4]NOAO, USA

High dispersion near-infrared spectra have been taken of seven highly-evolved, variable, intermediate-mass (4-6 $M_\odot$) AGB stars in the LMC and SMC in order to look for C, N and O variations that are expected to arise from third dredge-up and hot-bottom burning. The pulsation of the objects has been modelled, yielding stellar masses, and

spectral synthesis calculations have been performed in order to derive abundances from the observed spectra. For two stars, abundances of C, N, O, Na, Al, Ti, Sc and Fe were derived and compared with the abundances predicted by detailed AGB models. Both stars show very large N enhancements and C deficiencies. These results provide the first observational confirmation of the long-predicted production of primary nitrogen by the combination of third dredge-up and hot-bottom burning in intermediate-mass AGB stars. It was not possible to derive abundances for the remaining five stars: three were too cool to model, while another two had strong shocks in their atmospheres which caused strong emission to fill the line cores and made abundance determination impossible. The latter occurrence allows us to predict the pulsation phase interval during which observations should be made if successful abundance analysis is to be possible.

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Water vapor and silicon monoxide maser observations in the protoplanetary nebula OH 231.8+4.2

Desmurs, JF[1]*, Alcolea, J.*[1]*, Bujarrabal, V.*[2]*, Sánchez Contreras, S.*[3] *and Colomer, F.*[2]

[1]OAN, Madrid, Spain
[2]OAN, Alcalá de Henares, Spain
[3]DAMIR-CSIC, Madrid, Spain

OH 231.8+4.2 is a well studied preplanetary nebula (pPN) around a binary stellar system that shows a remarkable bipolar outflow. To study the structure and kinematics of the inner 10-80 AU nebular regions we performed high-resolution observations of the H_2O $6_{1,6}$–$5_{2,3}$ and ^{28}SiO v=2, J=1–0 maser emissions with the Very Long Baseline Array. The absolute position of both emission distributions were recovered using the phase referencing technique, and accurately registered in HST optical images. H_2O maser clumps are found to be distributed in two areas of 20 mas in size spatially displaced by ∼60 milli-arcseconds along an axis oriented nearly north-south. SiO masers are tentatively found to be placed between the two H_2O maser emitting regions, probably indicating the position of the Mira component of the system. The SiO maser emission traces an inner equatorial component with a diameter of 12 AU, probably a disk rotating around the M-type star. Outwards, we detect in the H_2O data a pair of polar caps, separated by 80 AU. We believe that the inner regions of the nebula probably have been altered by the presence of the companion, leading to an equator-to-pole density contrast that may explain the lack of H_2O masers and strong SiO maser emission in the denser, equatorial regions.

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Available from arXiv:0704.2166

An SiO Maser Search off the Galactic Plane

S. Deguchi[1]*, T. Fujii*[2,3]*, Y. Ita*[4,5]*, H. Imai*[2,3]*, H. Izumiura*[6]*, O. Kameya*[7]*, N. Matsunaga*[4]*, A. Miyazaki*[1,7,8]*, A. Mizutani*[9,10]*, Y. Nakada*[4]*, J. Nakashima*[1,11] *and A. Winnberg*[1,12]

[1]Nobeyama Radio Observatory, National Astronomical Observatory, Japan
[2]VERA Project Office, National Astronomical Observatory, Japan
[3]Faculty of Science, Kagoshima University, Japan
[4]Institute of Astronomy, School of Science, The University of Tokyo, Japan
[5]Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, Japan
[6]Okayama Astrophysical Observatory, National Astronomical Observatory, Japan
[7]Mizusawa VERA Observatory, National Astronomical Observatory, Japan
[8]Shanghai Astronomical Observatory, Chinese Academy of Sciences, China
[9]Department of Astronomical Science, The Graduate University for Advanced Studies, Japan
[10]Koriyama City Fureai Science Center, Japan
[11]Academia Sinica, Institute of Astronomy and Astrophysics, Taiwan
[12]Onsala Space Observatory, Sweden

We have searched for the SiO J=1–0 v= 1 and 2 maser lines at ∼43 GHz in 277 2MASS/MSX/IRAS sources off the Galactic plane ($|b|\lesssim 3^\circ$), which resulted in 119 (112 new) detections. Among the new detections, are two very faint objects with MSX 12 μm flux densities below 2 Jy. These are likely to be O-rich AGB-stars associated with dwarf-galaxy tidal tails. The sample also includes medium bright MSX objects at moderately high Galactic latitudes ($3^\circ < |b| < 5^\circ$) and in the IRAS gap at higher latitudes. A signature of a warp of the inner Galactic disk is found for a disk subsample. This warp appears relatively strongly in the area of $0^\circ < l < 45^\circ$ and $3^\circ < |b| < 5^\circ$. We also found a group of stars that does not follow to the Galactic rotation. This feature appears in the Galactic disk at $l \sim 27^\circ$, and extends more than 15° in Galactic latitude, like a stream of tidal debris from a dwarf galaxy.

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and from http://www.nro.nao.ac.jp/library/report/list.html (No.651)

Near-infrared polarimetric study of the bipolar nebula IRAS 19312+1950

Murakawa, K.[1]*, Nakashima, J.*[2]*, Ohnaka, K.*[1] *and Deguchi, S.*[3]

[1]Max-Planck-Institut für Radioastronomie, Germany
[2]Academia Sinica, Institute of Astronomy and Astrophysics, Taiwan
[3]Nobeyama Radio Astronomy, National Astronomical Observatory of Japan, Japan

We obtained H-band polarimetric data of IRAS 19312+1950 using the near-infrared camera (CIAO) on the 8 m Subaru telescope. In order to investigate the physical properties of the central star and the nebula, we performed dust radiative transfer modeling and compared the model results with the observed spectral energy distributions (SEDs), the radial profiles of the total intensity image, and the fraction of linear polarization map. The total intensity image shows a nearly spherical core with $\sim 3''$ radius, an S-shaped arm extending $\sim 10''$ in the northwest to southeast direction, and an extended lobe towards the southwest. The polarization map shows a centro-symmetric vector alignment in almost the entire nebula and low polarizations along the S-shaped arm. These results suggest that the nebula is accompanied by a central star, and the S-shaped arm has a physically ring-like structure. From our radiative transfer modeling, we estimated the stellar temperature, the bolometric luminosity, and the current mass-loss rate to be 2800 K, 7000 $L_\odot$, and 5.3×10^{-6} $M_\odot$ yr^{-1}, respectively. Taking into account previous observational results, such as the detection of SiO maser emissions and silicate absorption feature in the 10 μm spectrum, our dust radiative transfer analysis based on our NIR imaging polarimetry suggests that (1) the central star of IRAS 19312+1950 is likely to be an oxygen-rich, dust-enshrouded AGB star and (2) most of the circumstellar material originates from other sources (e.g., ambient dark clouds) rather than as a result of mass loss from the central star.

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Semi-Regular Variables in the Solar Neighbourhood

I.S. Glass[1] *and F. van Leeuwen*[2]

[1]SAAO, South Africa
[2]IoA, Cambridge, UK

Period-luminosity sequences have been shown to exist among the Semi-Regular Variables (SRVs) in the Magellanic Clouds (Wood et al. 1999), the Bulge of the Milky Way galaxy (Glass & Schultheis 2003) and elsewhere. Using modern period and revised Hipparcos parallax data, this paper demonstrates that they also appear among the M-giant SRVs of the Solar Neighbourhood. Their distribution in the K, log P diagram resembles that of Bulge stars more closely

than those in the Magellanic Clouds. The prevalence of mass-loss among local M-type SRVs and its dependence on period and spectral sub-type are also discussed. $K - [12]$, a measure of circumstellar dust emission, increases clearly with V amplitude, M giant sub-type and $\log P$.

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Available from arXiv:0704.3150

IGR J16194−2810: a new symbiotic X-ray binary

N. Masetti[1], R. Landi[1], M.L. Pretorius[2], V. Sguera[2], A.J. Bird[2], M. Perri[3], P.A. Charles[4], J.A. Kennea[5], A. Malizia[1] and P. Ubertini[6]

[1]INAF - Istituto di Astrofisica Spaziale e Fisica Cosmica di Bologna, via Gobetti 101, I-40129 Bologna, Italy
[2]School of Physics & Astronomy, University of Southampton, Southampton, Hampshire, SO17 1BJ, United Kingdom
[3]ASI Science Data Center, via Galileo Galilei, I-00044 Frascati, Italy
[4]South African Astronomical Observatory, P.O. Box 9, Observatory 7935, South Africa
[5]Pennsylvania State University, 525 Davey Laboratory, University Park, PA 16802, USA
[6]INAF - Istituto di Astrofisica Spaziale e Fisica Cosmica di Roma, via Fosso del Cavaliere 100, I-00133 Roma, Italy

We here report on the multiwavelength study which led us to the identification of X–ray source IGR J16194−2810 as a new Symbiotic X–ray Binary (SyXB), that is, a rare type of Low Mass X–ray Binary (LMXB) composed of a M-type giant and a compact object. Using the accurate X–ray position allowed by *Swift*/XRT data, we pinpointed the optical counterpart, a M2 III star. Besides, the combined use of the spectral information afforded by XRT and *INTEGRAL*/IBIS shows that the 0.5–200 keV spectrum of this source can be described with an absorbed Comptonization model, usually found in LMXBs and, in particular, in SyXBs. No long-term (days to months) periodicities are detected in the IBIS data. The time coverage afforded by XRT reveals shot-noise variability typical of accreting Galactic X–ray sources, but is not good enough to explore the presence of X–ray short-term (seconds to hours) oscillations in detail. By using the above information, we infer important parameters for this source such as its distance (∼3.7 kpc) and X–ray luminosity (∼1.4×10^{35} erg s^{-1} in the 0.5–200 keV band), and we give a description for this system (typical of SyXBs) in which a compact object (possibly a neutron star) accretes from the wind of its M-type giant companion. We also draw some comparisons between IGR J16194−2810 and other sources belonging to this subclass, finding that this object resembles SyXBs 4U 1700+24 and 4U 1954+31.

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Available from arXiv:0704.3682

Conference Papers

SiO maser observations of a wide dust-temperature range sample

Jun-ichi Nakashima[1] and Shuji Deguchi[2]

[1]Academia Sinica Institute of Astronomy and Astrophysics, P.O. Box 23-141, Taipei 10617, Taiwan
[2]Nobeyama Radio Observatory, National Astronomical Observatory, Minamimaki, Minamisaku, Nagano 384-1305, Japan

We present the results of SiO line observations of a sample of known SiO maser sources covering a wide dust-temperature range. The aim of the present research is to investigate the causes of the correlation between infrared colors and SiO maser intensity ratios among different transition lines. We observed in total 75 SiO maser sources with the Nobeyama 45m telescope quasi-simultaneously in the SiO $J = 1-0$ $v = 0$, 1, 2, 3, 4 and $J = 2-1$ $v = 1$, 2 lines. We also observed the sample in the ^{29}SiO $J = 1-0$ $v = 0$ and $J = 2-1$ $v = 0$, and ^{30}SiO $J = 1-0$ $v = 0$ lines, and the

H_2O $6_{1,6}-5_{2,3}$ line. As reported in previous papers, we confirmed that the intensity ratios of the SiO $J = 1-0$ $v = 2$ to $v = 1$ lines clearly correlate with infrared colors. In addition, we found possible correlation between infrared colors and the intensity ratios of the SiO $J = 1-0$ $v = 3$ to $v = 1\&2$ lines.

Oral contribution, published in IAU Symp. 242, "Astrophysical masers and their environments"
Available from arXiv:0704.1063

658 GHz Vibrationally-Excited Water Masers with the Submillimeter Array

T.R. Hunter[1]*, K.H. Young*[2]*, R.D. Christensen*[3] *and M.A. Gurwell*[2]

[1]NRAO, USA
[2]Harvard-Smithsonian Center for Astrophysics, USA
[3]Submillimeter Array, USA

Discovered in 1995 at the Caltech Submillimeter Observatory (CSO) by Menten and Young, the vibrationally-excited water maser line at 658 GHz (455 μm) is seen in oxygen-rich giant and supergiant stars. Because this maser can be so strong (up to thousands of Janskys), it was very helpful during the commissioning phase of the highest frequency band (620-700 GHz) of the Submillimeter Array (SMA) interferometer. From late 2002 to early 2006, brief attempts were made to search for emission from additional sources beyond the original CSO survey. These efforts have expanded the source count from 10 to 16. The maser emission appears to be quite compact spatially, as expected from theoretical considerations; thus these objects can potentially be used as atmospheric phase calibrators on short baselines. Many of these objects also exhibit maser emission in the vibrationally-excited SiO maser at 215 GHz. Because both maser lines likely originate from a similar physical region, these objects can be used to test techniques of phase transfer calibration between millimeter and submillimeter bands. The 658 GHz masers will be important beacons to assess the performance of the Atacama Large Millimeter Array (ALMA) in this challenging high-frequency band.

Oral contribution, published in IAU Symposium 242: Astrophysical Masers and their Environments
Available from arXiv:0704.2655

Review Paper

Structure and Evolution of Low-Mass Stars: An Overview and Some Open Problems

M. Catelan[1]

[1]Pontificia Universidad Católica de Chile, Chile

A review is presented of some of the ingredients, assumptions and techniques that are used in the computation of the structure and evolution of low-mass stars. Emphasis is placed on several ingredients which are still subject to considerable uncertainty. An overview of the evolution of low-mass stars is also presented, from the cloud collapse phase all the way to the white dwarf cooling curve.

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Announcement

A Database of Circumstellar OH Masers

We present a new database of circumstellar OH masers at 1612, 1665, and 1667 MHz. The database contains 10774 observations and 2274 stars with OH maser emission detected. The database contains flux densities and velocities of the two strongest maser peaks, the expansion velocity of the shell and the radial velocity of the star. Access to the database is possible over the Web, allowing cone searches for individual objects and lists of objects. Object selection is possible on the base of flux densities and velocities.

Dieter Engels and Felix Bunzel,
Hamburger Sternwarte
Gojenbergsweg 112,
D-21029 Hamburg

See also www.hs.uni-hamburg.de/maserdb