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Abstracts of recently accepted papers

On an alternative statistical distance scale for planetary nebulae

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We propose to use the correlation between the distance-independent radio continuum brightness temperature and the distance-dependent radius to determine statistical distances to planetary nebulae. This correlation satisfies two objective criteria which define a statistical distance scale: (1) We obtain the same calibration relation for the large sample of Galactic bulge planetary nebulae as for a small sample of non–bulge planetary nebulae with well-determined distances, showing that the method is applicable to different PN populations. (2) The distribution of the distances to the Galactic bulge planetary nebulae is in agreement with the expected distribution of distances around the Galactic center. Distances could be determined to better than a factor 2 for 95% of the planetary nebulae, and on average to an accuracy of about 40%. It is an essential requirement that the optically thin radio flux and corresponding angular diameter be used in calculation of the brightness temperature. We show that the correlation also reproduced by model calculations of PN evolution. We show that the new calibration of the Daub scale obtained by Cahn et al. (1992) also gives the correct average distance to the large sample of bulge planetary nebulae, but gives a skewed distribution around the Galactic Center, Models show that this is caused by the fact that for young nebulae the Daub track does not follow evolutionary model curves.

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More (on) red giants with unusual dust shells

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Twenty-four M- and MS-stars have been suggested in the literature to show the silicon carbide feature, indicative of a carbon-rich circumstellar shell. By cross-correlating the IRAS LRS atlas with Bidelman's compilation of spectral types for objects in the IRC survey, this sample is enlarged to 39 sources. By carefully examining the LRS spectra, it appears that only one source shows silicon carbide emission. However, there is doubt on the correct association of this IRC source with the IRAS source and on the spectral type of the IRC source. The remaining objects are shown to have no dust, featureless dust, to show the characteristic silicate feature at

18 μm, or to display a broad feature from 10-14 μm which is known from previous studies on the dust around M-stars. I conclude that based on the present sample there is no or weak evidence that silicon carbide dust forms in the shells around M- and MS-stars.

Accepted by Astron. Astrophys. *For preprints, contact* groen@iap.fr

Location of PN central stars on the HR diagram

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Galactic planetary nebulae (PN) form a complex system, which includes objects with different characteristics and evolutionary stage. The location of a sample of galactic PN central stars on the HR diagram is attempted, in order to investigate the correspondence of the PN properties such as chemical composition, space distribution and kinematics, with the main sequence masses of their progenitor stars.

accepted by Astronomy and Astrophysics *For preprints, contact* maciel@iag.usp.ansp.br

The Near-Infrared Structure and Spectra of the Bipolar Nebulae M 2–9 and AFGL 2688: The Role of UV–pumping and Shocks in Molecular Hydrogen Excitation

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High-resolution near-infrared images and moderate resolution spectra were obtained of the bipolar nebulae M 2–9 and AFGL 2688. The ability to spatially and spectrally resolve the various components of the nebulae has proved to be important in determining their physical structure and characteristics. In M 2–9, the lobes are found to have a double-shell structure. The inner shell is dominated by emission from hydrogen recombination lines, and the outer shell is primarily emission from H_2 lines in the 2 – 2.5 μm region. Analysis of H_2 line ratios indicates that the H_2 emission is radiatively excited. A well-resolved photodissociation region is observed in the lobes. The spectrum of the central source is dominated by H recombination lines and a strong continuum rising towards longer wavelengths consistent with a $T = 795$ K blackbody. Also present are lines of He I and [Fe II]. In contrast, the N knot and E lobe of M 2–9 show little continuum emission. The N knot spectrum consists of lines of [Fe II] and hydrogen recombination lines. In AFGL 2688, the emission from the bright lobes is mainly continuum reflected from the central star. Several molecular features from C_2 and CN are present. In the extreme end of the N lobe and in the E equatorial region, the emission is dominated by lines of H_2 in the 2 – 2.5 μm region. The observed H_2 line ratios indicate that the emission is collisionally excited, with an excitation temperature $T_{ex} \approx 1600 \pm 100$ K.

Accepted by the Astrophysical Journal *For preprints, contact* hora@galileo.ifa.hawaii.edu

K'-Band Spectro-imagery of AFGL 2688 and NGC 7027

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We report high spatial and spectral resolution near-infrared mapping results in the K'–Band obtained with BEAR towards the proto-planetary nebula AFGL 2688 and the planetary nebula NGC 7027. The H_2 morphology and excitation of these two key sources are consistent with an evolutionary scheme in which: i) AFGL 2688 represents the proto-planetary phase where fast winds ram into the slower expanding AGB envelope, developing strong shocks which are able to excite the H_2 and, ii) NGC 7027 the paradigm of the planetary nebula phase where the ultraviolet radiation of the central, hot degenerated star ionizes the inner cavity and excites the molecular hydrogen in PDRs.

To appear in Proceedings of IAU symposium 149 "3D optical spectroscopy" *For preprints, contact* p427cox@mpifr-bonn.mpg.de

Accurate Radio Positions of SiO Masers

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Highly accurate radio positions of the v=1, J=2-1 SiO maser sources observed with the IRAM interferometer toward 13 late-type stars and the infrared object IRc2 in Orion, are presented. The coordinates are directly derived in the J2000 system after the baseline vectors have been oriented with respect to the extragalactic frame formed by distant quasars. We estimate the final accuracy of our 'absolute' positions of SiO masers to lie in the range 0.1" to 0.2 " in general. The optical and radio centers coincide within the uncertainties. However, in the complex supergiants VY CMa and VX Sgr there is a clear offset between the optical and radio positions. Spatial structure is present in our SiO data since we have observed in several stars relative position offsets larger than about 20-50 milliarc sec. The radio and optical J2000 positions are compared and discussed, and we suggest that accurate position measurements of maser sources associated with stars may valuably contribute to the alignment of the fundamental optical and extragalactic reference frames.

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Time resolved spectroscopy of the post-AGB star HD 56126

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We have investigated the report of Tamura and Takeuti that the Hα line of the F type post-AGB star HD 56126 is variable on timescales of minutes. To this end, HD 56126 was observed on two occasions with the William Herschel Telescope. Seventeen, respectively thirty spectra were taken within timespans of 1.5 hours in order

to detect any short term variations. We find that the Hα line profile changed strongly over the two month interval, but no evidence is found for short term variability. The variability Tamura and Takeuti claim to find is probably due to the low signal-to-noise in their spectra.

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"Fossil" symbiotic novae

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While a symbiotic nova's outburst quickly degrades the molecular content of a circumstellar shell, it takes $\approx$ 1000 yr to move fresh material out from a star to its OH masing zone. During this post-outburst phase a shell lacks its usual complement of molecules, and so bears a stamp from the nova outburst, even though it is no longer a soft X-ray, UV or radio source. These objects are "fossil" symbiotic novae. The number of potential "fossils" with dense shells is commensurate with the frequency of observed Galactic symbiotic novae.

The densest O-rich shells exhibit the 9.7 μm silicate line as a strong absorption feature. This places them in the IRAS low resolution spectral type 38-39 class. About 50 % of these mass-losing giants have had comparably massive companions. Of 38 class members examined at 1612 MHz, 32 exhibit masers. But six (16 %) lack them. We identify these six with "fossil" symbiotic novae.

Accepted by Astronomy and Astrophysics (Letters) *For preprints, contact* blewis@naic.edu

Dissertation Abstracts

A spectroscopic study of the progenitor of supernova 1987A

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The narrow line emission from Supernova (SN) 1987A is believed to originate from circumstellar material which was ejected by the progenitor star and ionised by the extreme ultraviolet (EUV) burst which accompanied the supernova explosion. Imaging has shown that the brightest circumstellar gas is in the form of an elliptical ring about 1 light year from the supernova. Here I report high-resolution optical spectroscopy of the circumstellar medium (CSM), taken with the UCL échelle spectrograph at the Anglo-Australian Telescope between 1990 March and 1992 December. I have used the profiles of the narrow lines to test models of the CSM, thereby providing constraints for models of the mass-loss history and evolution of the progenitor.

I have constructed model profiles using nebular and kinematic models for the ring, taking account of the observational effects of seeing and finite spectral resolution. The nebular model was supplied by P. Lundqvist. All the lines show a velocity gradient across the nebula which confirms that the ring is intrinsically circular and expanding at 10.3$\pm$0.4 km s^{-1}. Comparison of NII λ6583 and λ5755 profiles has indicated a persistent temperature difference across the ring: the north side of the ring is hotter than the south side. This temperature difference can be easily explained if the ring material is less dense in the north than in the south. The later observations show a slight relative brightening of the northern side of the ring which is consistent with this picture.

About 10% of the CSM emission comes from gas at higher velocities than the ring. The measured velocities (up to $\pm$ $\sim$30 km s^{-1} relative to the ring) are consistent with an origin in a homologously-expanding hourglass-shaped shell whose waist is the ring, in agreement with recent hydrodynamic models.

The Hα line has shown a transient, extremely narrow component, which is attributed to a cold, dense cloud behind the supernova, at the interface of the fast and slow progenitor winds. The feature's narrowness is extremely hard to explain in terms of standard nebular physics.

Defence took place on May 23rd, 1994. *To obtain a copy, please contact* robert@astro.su.se

Messages

During the conference on circumstellar matter in Edinburgh at the end of August, a review will be given on stellar evolution on the AGB and mass loss. It is a broad subject and will probably also include hydrogen-deficient outflows from post-AGB stars.

I would appreciate receiving re- and preprints of work you would like to be included in the review. Descriptions of work in progress are also welcome, if possible with an indication where and when it will be published.

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