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Abstract of recently accepted papers

Temperature effects on the 15-85-μm Spectra of Olivines and Pyroxenes

J. E. Bowey[1,2], C. Lee[1], C. Tucker[1], A. M. Hofmeister[3], P. A. R. Ade[1] and M. J. Barlow[2]

[1] Dept. of Physics, Queen Mary, University of London, Mile End Road, London, E1 4NS, UK.

[2] Dept. of Physics & Astronomy, University College London, Gower Street, London, WC1E 6BT (e-mail: jeb@star.ucl.ac.uk)

[3]Dept. Earth & Planet. Sci., Washington University, 1 Brookings Dr., St Louis, MO 63110, USA. Far-infrared spectra of laboratory silicates are normally obtained at room temperature even though the grains responsible for astronomical silicate emission bands seen at wavelengths > 20 μm are likely to be at temperatures below ~ 150 K. In order to investigate the effect of temperature on silicate spectra, we have obtained absorption spectra of powdered forsterite and olivine, along with two orthoenstatites and diopside clinopyroxene, at 3.5$\pm$0.5 K and at room temperature (295$\pm$2 K). To determine the changes in the spectra the resolution must be increased from ~ 1 to 0.25 cm^{-1} at both temperatures since a reduction in temperature reduces the phonon density, thereby reducing the width of the infrared peaks. Several bands observed at 295 K split at 3.5 K. At 3.5 K the widths of isolated single bands in olivine, enstatites and diopside are $\sim 90\%$ of their 295 K-widths. However, in forsterite the 3.5-K–widths of the 31-, 49- and 69-μm bands are, respectively, 90%, 45% and 31% of their 295 K widths. Due to an increase in phonon energy as the lattice contracts, 3.5-K–singlet peaks occur at shorter wavelengths than do the corresponding 295-K peaks; the magnitude of the wavelength shift increases from $\sim 0 - 0.2$ μm at 25 μm to ~ 0.9 μm at 80 μm. In olivines and enstatites the wavelength shifts can be approximated by polynomials of the form $ax + bx^2$ where $x = \lambda_{pk}(295\ \mathrm{K})$ and the coefficients a and b differ between minerals; for diopside this formula gives a lower limit to the shift. Changes in the relative absorbances of spectral peaks are also observed. The temperature dependence of λ_{pk} and bandwidth shows promise as a means to deduce characteristic temperatures of mineralogically distinct grain populations. In addition, the observed changes in band strength with temperature will affect estimates of grain masses and relative mineral abundances inferred using room-temperature laboratory data. Spectral measurements of a variety of minerals at a range of temperatures are required to fully quantify these effects.

Accepted by MNRAS

Preprints can be obtained by contacting jeb@star.ucl.ac.uk *or via WWW on* http://arXiv.org/abs/astro-ph/0103297

A 2000 km s^{-1} "pristine" post-AGB wind in the protoplanetary nebula He 3-1475

C. Sánchez Contreras and R. Sahai

Jet Propulsion Laboratory, MS 183-900, 4800 Oak Grove Drive, Pasadena, CA 91109

We analyse (archival) STIS long-slit Hα spectra of the protoplanetary nebula He 3-1475. We find two remarkable blue-shifted absorption features arising from the inner $\sim 5\times10^{16}$ cm of the nebula, revealing the presence of two different winds outflowing at high velocity from the central star. The kinematic age of these winds is only tens of years. We find that the fast wind is flowing with velocities in the range $\sim$ 150–1200 km s^{-1}, whereas the ultra-fast wind is moving much faster (up to 2300 km s^{-1}). The latter is highly collimated (length/width $\gtrsim 7$) close to the central star ($\sim 10^{16}$ cm) along a direction different from previous mass-ejection axes and shows a radially increasing velocity. We identify the ultra-fast wind with a "pristine" post-AGB outflow which has not been (strongly) altered by its interaction with the AGB envelope. We discuss the implications of the spatio-kinematic structure of this wind for current theories of the formation and shaping of planetary nebulae.

Accepted by the Astrophysical Journal (Letters)

Preprints can be obtained by contacting sanchez@eclipse.jpl.nasa.gov

The abundance pattern of two barium stars in the galactic halo: HD 104340 and HD 206983

S. Junqueira[1] *and C. B. Pereira*[1]

[1] Observatório Nacional/MCT, Rua Gen. José Cristino, 77, 20921-400, Rio de Janeir o, Brazil

We present the abundance pattern of two barium stars in the galactic halo; HD 104340 and HD 206983 based on high-resolution optical spectra. We also determined the spectroscopic stellar atmospheric parameters, temperature and microturbulent velocity as well as stellar surface gravity from a solution of excitation and ionization equilibria of Fe I and Fe II lines under the assumption of local thermodynamic equilibrium. The abundance analysis reveals HD 104340 to be a metal-poor K giant with [Fe/H]=-1.72 and HD 206983 also a metal-poor K giant with [Fe/H]=-1.43. From a set of Fe I lines, the radial velocity are found to be, respectively, 263.3±0.6 km/s and -319.2±4.4 km/s for HD 104340 and HD 206983. Their high velocity, low-metallicity and high galactic latitude point both stars as being members of galactic halo population. From our study and using information from the literature we believe that HD 206983 is another member of group known as "metal-deficient barium stars".

We compare the abundance pattern with abundances of halo population. We found that of iron group, α-elements, manganese, cooper and zinc as well as sodium and magnesium of HD 104340 and HD 206983 follow the abundance pattern of halo population. The heavy-element abundance pattern of both stars shows enhancements by a factor of 4-8 with respect of the metal-poor stars with the same metallicity analyzed by us. We also discuss the abundances of the s-process elements and compare our results with other objects that display the same degree of enrichment due to neutron-capture reactions, binary systems and AGB stars, through a diagram metallicity versus neutron exposure given by the [hs/ls]-index.

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Preprints can be obtained by contacting claudio@on.br

Reprocessing the *Hipparcos* data for evolved giant stars II. Absolute magnitudes for the R-type carbon stars

G. R. Knapp[1], *D. Pourbaix*[1,2], *and A. Jorissen*[2]

[1]Department of Astrophysical Sciences, Princeton University, Princeton, NJ 08544-1001, U.S.A.

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

The Hipparcos *Intermediate Astrometric Data* for carbon stars have been reprocessed using an algorithm which provides an objective criterion for rejecting anomalous data points and constrains the parallax to be positive. New parallax solutions have been derived for 317 cool carbon stars, mostly of types R and N. In this paper we discuss the results for the R stars. The most important result is that the early R stars (i.e., R0 – R3) have absolute magnitudes and $V-K$ colors locating them among red clump giants in the Hertzsprung-Russell diagram. The average absolute magnitude $M_{\rm K}$ for early R-type stars (with $V-K<4$) has been derived from a Monte-Carlo simulation implicitly incorporating all possible biases. It appears that the simulated magnitude distribution for a population with a true Gaussian distribution of mean $M_K=-2.0$ and intrinsic standard deviation 1.0 mag provides a satisfactory match to the observed distribution. These values are consistent with the average absolute magnitude $M_{\rm K}=-1.6$ for clump red giants in the solar neighborhood (Alves 2000). Further, early R-type stars are non-variable, and their infrared photometric properties show that they are not undergoing mass loss, properties similar to those of the red clump giants.
Stars with subtypes R4 – R9 tend to be cooler and have similar luminosity to the N-type carbon stars, as confirmed by their position in the $(J-H, H-K)$ color-color diagram.
The sample of early R-type stars selected from the Hipparcos Catalogue appears to be approximately complete to magnitude $K_0\sim 7$, translating into a completeness distance of 600 pc if all R stars had $M_K=-2$ (400 pc if $M_K=-1$). With about 30 early R-type stars in that volume, they comprise about 0.04% (0.14% for $M_K=-1$) of the red clump stars in the solar neighborhood. Identification with the red clump locates these stars at the helium core burning stage of stellar evolution, while the N stars are on the asymptotic giant branch, where helium shell burning occurs. The present analysis suggests that for a small fraction of the helium core burning stars (far lower than the fraction of helium shell-burning stars), carbon produced in the interior is mixed to the atmosphere in sufficient quantities to form a carbon star.

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Preprints can be obtained by contacting gk@astro.princeton.edu *or via WWW:* astro-ph/0103141

Origin of quasi–periodic shells in dust forming AGB winds

Y.J.W. Simis[1], *V. Icke*[2] *and C. Dominik*[2]

[1] Leiden Observatory, P.O. Box 9513, 2300 RA Leiden, The Netherlands

[2] Astronomical Institute "Anton Pannekoek", University of Amsterdam, Kruislaan 403, 1098 SJ Amsterdam, The Netherlands

We have combined time dependent hydrodynamics with a two–fluid model for dust driven AGB winds. Our calculations include self–consistent gas chemistry, grain formation and growth, and a new implementation of the viscous momentum transfer between grains and gas. This allows us to perform calculations in which no assumptions about the completeness of momentum coupling are made. We derive new expressions to treat time dependent and non–equilibrium drift in a hydro code. Using a stationary state calculation for IRC +10216 as initial model, the time dependent integration leads to a quasi–periodic mass loss in the case where dust drift is taken into account. The time scale of the variation is of the order of a few hundred years, which corresponds to the time scale needed to explain the shell structure of the envelope of IRC +10216 and other AGB and post-AGB stars, which has been a puzzle since its discovery. No such periodicity is observed in comparison models without drift between dust and gas.

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Preprints can be obtained by contacting simis@strw.leidenuniv.nl *or via anonymous ftp on*
ftp://ftp.strw.leidenuniv.nl/pub/simis/papers/simis10276.ps.gz

Imaging of detached shells around the carbon stars R Scl and U Ant through scattered stellar light

D. González Delgado[1], *H. Olofsson*[1], *H.E. Schwarz*[2], *K. Eriksson*[3], *B. Gustafsson*[3]

[1] Stockholm Observatory, SE-133 36 Saltsjöbaden, Sweden

[2] CTIO, Casilla 603, La Serena, Chile

[3] Uppsala Astronomical Observatory, Box 515, SE-751 20 Uppsala, Sweden

We present the first optical images of scattered light from large, detached gas/dust shells around two carbon stars, R Scl and U Ant, obtained in narrow band filters centred on the resonance lines of neutral K and Na, and in a Strömgren b filter (only U Ant). They confirm results obtained in CO radio line observations, but also reveal new and interesting structures. Towards R Scl the scattering appears optically thick in both the K and Na filters, and both images outline almost perfectly circular disks with essentially uniform intensity out to a sharp outer radius of $\approx 21''$. These disks are larger – by about a factor of two – than the radius of the detached shell which has been marginally resolved in CO radio line data. In U Ant the scattering in the K filter appears to be, at least partially, optically thin, and the image is consistent with scattering in a geometrically thin ($\approx 3''$) shell (radius $\approx 43''$) with an overall spherical symmetry. The size of this shell agrees very well with that of the detached shell seen in CO radio line emission. The scattering in the Na filter appears more optically thick, and the image suggests the presence of at least one, possibly two, shells inside the $43''$ shell. There is no evidence for such a multiple-shell structure in the CO data, but this can be due to considerably lower masses for these inner shells. Weak scattering appears also in a shell which is located outside the $43''$ shell. The present data do not allow us to conclusively identify the scattering agent, but we argue that most of the emission in the K and Na filter images is to due to resonance line scattering, and that there is also a weaker contribution from dust scattering in the U Ant data. Awaiting new observational data, our interpretation must be regarded as tentative.

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Preprints can be obtained by contacting delgado@astro.su.se or via WWW on http://arXiv.org/abs/astro-ph/0104140

The complete ISO spectrum of NGC 6302

F.J. Molster[1], *T.L. Lim*[2], *R.J. Sylvester*[3], *L.B.F.M. Waters*[1,4], *M.J. Barlow*[3], *D.A. Beintema*[5], *M. Cohen*[6], *P. Cox*[7] *and B. Schmitt*[8]

[1] Astronomical Institute 'Anton Pannekoek', University of Amsterdam, Kruislaan 403, 1098 SJ Amsterdam, The Netherlands

[2] Space Science Department, Rutherford Appleton Laboratory, Chilton, Didcot, OX11 0QX, United Kingdom

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

[4] Instituut voor Sterrenkunde, K.U. Leuven, Celestijnenlaan 200B, 3001 Heverlee, Belgium

[5] SRON Space Research Laboratory, P.O. Box 800, NL-9700 AV Groningen, The Netherlands

[6] Radio Astronomy Laboratory, 601 Campbell Hall, University of California, Berkeley, CA 94720

[7] Institut d'Astrophysique Spatiale, Bât 121, Université de Paris XI, F-91405 Orsay Cedex, France

[8] Laboratoire de Planetologie de Grenoble, Universite J. Fourier - CNRS, Batiment D de Physique, BP 53, 38041 Grenoble Cedex 9, France

We present the combined Infrared Space Observatory Short-Wavelength Spectrometer and Long-Wavelength Spectrometer 2.4–197 μm spectrum of the Planetary Nebula NGC 6302 which contains in addition to strong atomic lines, a series of emission features due to solid state components. The broad wavelength coverage enables us to more accurately identify and determine the properties of both oxygen- and carbon-rich circumstellar dust. A simple model fit was made to determine the abundance and typical temperature of the amorphous silicates, enstatite and forsterite. Forsterite and enstatite do have roughly the same abundance and temperature. The origin and location of the dust in a toroidal disk around the central star are discussed.

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Preprints can be obtained by contacting fjmolster@mvainc.com *or via WWW on* http://www.astro.uva.nl/f̃rankm/papers.html

LATE AGB MAGNETIC CYCLES: MHD SOLUTIONS FOR THE HST PN RINGS

Guillermo García-Segura, José Alberto López, José Franco

Instituto de Astronomía-UNAM, Apdo Postal 877, Ensenada, 22800 Baja California, Mexico; Email address: ggs@astrosen.unam.mx

The Hubble Space Telescope has revealed the existence of multiple, regularly spaced, and faint concentric shells around some planetary nebulae. Here we present 2(1/2)D magnetohydrodinamic numerical simulations of the effects of a solar-like magnetic cycle, with periodic polarity inversions, in the slow wind of an AGB star. The stellar wind is modeled with a steady mass-loss at constant velocity. This simple version of a solar-like cycle, without mass-loss variations, is able to reproduce many properties of the observed concentric rings. The shells are formed by pressure oscillations, which drive compressions in the magnetized wind. These pressure oscillations are due to periodic variations in the field intensity. The periodicity of the shells, then, is simply a half of the magnetic cycle, because each shell is formed when the magnetic pressure goes to zero during the polarity inversion. As a consequence of the steady mass-loss rate, the density of the shells scales as r^{-2}, and their surface brightness has a steeper drop-off, as observed in the shells of NGC 6543, the best documented case of these HST rings. Deviations from sphericity can be generated by changing the strength of the magnetic field. For sufficiently strong fields, a series of symmetric and equisdistant blobs are formed at the polar axis, resembling the ones observed in He 2-90. These blobs are originated by magnetic collimation within the expanding AGB wind.

Submitted to ApJLett.

Preprints can be obtained by anonymous ftp to pegasus.astroscu.unam.mx 132.248.1.8 // pub/temporal/GGS
www http://arXiv.org/abs/astro-ph/0104154

Spectra of carbon-rich asymptotic giant branch stars between 0.5 and 2.5 μm: theory meets observation

Rita Loidl[1], *Ariane Lançon*[2], *and Uffe G. Jørgensen*[3]

[1] Institut für Astronomie der Universität Wien, Türkenschanzstraße 17, A-1180 Wien, Austria

[2] Observatoire de Strasbourg, UMR 7550, 11 Rue de l'Université, F-67000 Strasbourg, France

[3] Niels Bohr Institute, Astronomical Observatory, Juliane Maries Vej 30, DK-2100 Copenhagen, Denmark

We present a hydrostatic analysis of five carbon rich stars, BH Cru, T Cae, S Cen, RU Pup and Y Hya in the wavelength range between 0.5 and 2.5 μm. All except BH Cru, which is a Mira star, show only modest variability. We identify the absorption features of the molecules CO, CN and C_2. The overall energy distribution, which is very sensitive to the effective temperature in the investigated wavelength range, as well as the bands of these molecules put strict limits on the possible values of effective temperature and C/O. We show that our model atmospheres and corresponding synthetic spectra are able to reproduce the observed spectra quite accurately from about 0.7 to 2.5 μm. The discrepancies are mainly due to uncertainties in the molecular input data. We discuss briefly why the variations of the molecular features are small and why dynamic phenomena do not play a very important role in this wavelength range. We identify colour indices based on commonly available filters and potentially suitable for the empirical determination of fundamental parameters of carbon stars.

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