IRAM Newsletter

Number 14 March 22, 1994

Calendar 1994

Observing proposals:
Proposals for the period:
Nov. 15, 1994 to May 15, 1995
should be submitted before:
Tuesday, September 1st 1994

IRAM S.A.C. Meeting:
April 20th,21st, 1994
Location: Grenoble

IRAM Council Meeting:
June 27,28th, 1994
Location: Bonn

Contents

30-m Telescope

345 GHz Observing Period from February 1 to 15

The IRAM 345 GHz SIS receiver was installed at the telescope on February 1 and 2, and it was available for antenna efficiency measurements and observations until February 15. The installation went smoothly without problems. See the Receiver section below for more details (page 3).

During the first week, few observations were possible due to bad weather, but in the second week, the receiver could be used during longer periods. The best zenith optical depth at 345 GHz was around 0.2 .

A detailed report about this 345 GHz observing period and antenna efficiency measurements is currently being prepared.

New 230 G2 Mixer

A new mixer was installed in the 230 G2 receiver during the 345 GHz observing period. The previous G2 mixer had shown serious signs of degradation. The set of tuning parameters for the receiver is not yet fully established. See the Receiver section below for more details (page 1).

Computer Questionnaire

Observers who recently came to the 30m telescope have probably noticed that they not only get the *Observer's Report* sheet but also a questionnaire about computers. We would like to have some feedback from observers on their needs and wishes in terms of computers, data reduction software and tape devices for the 30m telescope. We ask observers to fill out this questionnaire and leave it with the astronomer on duty or the operator (together with the *Observer's Report*).

Public Telephone at the Granada Office

A public telephone is now installed in the entrance lounge of the Granada office. It accepts coins of 5, 10, 25, 50, and 100 Pesetas (no credit or telephone cards, unfortunately – the Spanish telephone company *TELEFONICA* doesn't allow this option for privately installed telephones). The telephone can be used for local, national and international calls at any time, and it also can be called from outside at any time. The installation of this telephone enables guest observers to make international calls outside office hours (try to bring enough coins, however, or have you called back).

Wolfgang WILD

Receiver News

A new SIS mixer for the 230 GHz G2 receiver at the 30-m telescope

The new mixer design goals have been fixed as follows:

1. Low noise operation in the frequency range 210 - 245 GHz LO.
2. SIS mixer should be tunable to single sideband operation in the whole 210–245 GHz band.
3. Stable receiver output power in DSB and SSB operation.

The principal feature of this design is the use of individual inductive tuning of the SIS junctions and optimization of the mixer circuit elements, with the aim of having a simple tuning for the SSB operation and of insuring the stability of the receiver operation in SSB mode across the RF band. Special attention has been paid to get the optimal operation around the most commonly used frequencies, 220 and 230 GHz.

G2 receiver tests with the new 1.3 mm SIS mixer

The G2 receiver with the new mixer was tested off-line at Pico Veleta in February 1994. In this test a standard receiver configuration was used: MK3 cryostat with ambient temperature optics, local oscillator power injection through the dual beam interferometer diplexer, and the standard local oscillator. The IF chain has been changed. In the cryostat is now installed a 3.5-4.5 GHz Berkshire IF amplifier with a noise temperature of 6 K. The receiver output bandwidth is limited to 3.7–4.3 GHz by the filter in the uncooled IF amplifier. The infrared filters in the cryostat were replaced too.

First the receiver has been tuned in SSB operation. The backshort to junction distance was optimized in order to have a 16–20 dB rejection of the upper sideband. The SSB receiver noise temperature, measured in front of the receiver, is presented in Fig. 1. Upper sideband rejection for this SSB tuning is presented in Fig. 2. Noise temperature $T_{\rm ref}$ measured in the reference plane of the automatic cold and hot calibration loads may be 40–60 K higher than in Fig. 1 due to : a) cross-polarization of the receiver optics b) sidelobes of the receiver optics, and c) the loss in the multiplexing system of the receiver cabin.

Next the receiver noise temperature corresponding to the approximate balance between the sidebands (± 2 dB) has been measured for the backshort positions close to SSB tuning. This "DSB" noise temperature is also presented in Fig. 1. Minimum receiver noise is about 65 K.

Status of the 230 Ghz G1 receiver

Operation of the G1 receiver has been verified on February 15, in the 210-240 GHz band commonly used at IRAM 30m telescope. In this frequency band receiver output

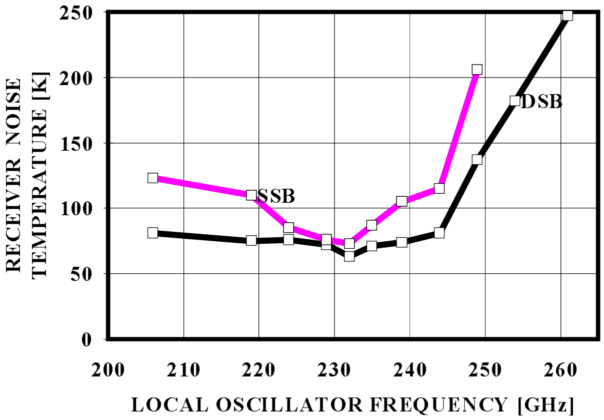

Figure 1: G2 receiver SSB noise temperature (SSB tuning) and DSB noise temperature (DSB tuning). Noise temperature is measured directly in front of the receiver. In regular operation, the noise temperature is measured at a standard reference plane, and includes some optics losses (see text).

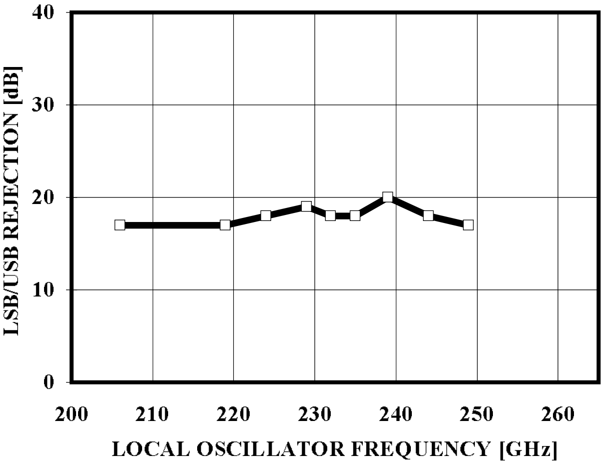

Figure 2: Upper sideband rejection in the G2 receiver in SSB mode.

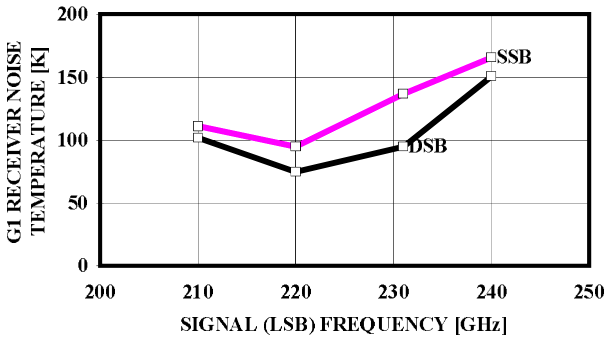

Figure 3: G1 receiver SSB noise temperature (SSB tuning) and DSB noise temperature (DSB tuning). Noise temperature is measured in front of the receiver (see note in caption of Fig.1).

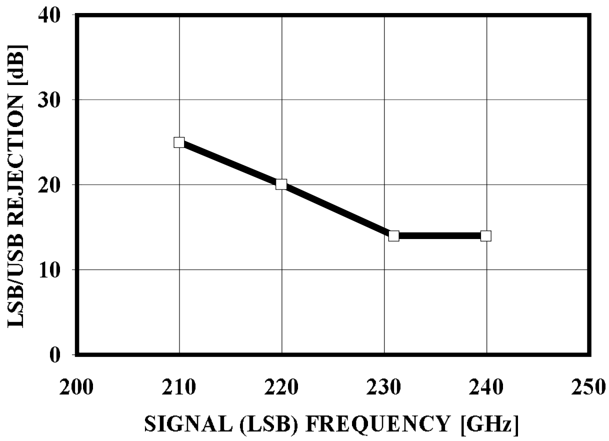

Figure 4: Upper sideband rejection of the G1 receiver in SSB mode.

power has been found stable in double sideband and single sideband mixer operations ($\simeq 0.1\%$ over 1s timescale). The minimum receiver noise temperature measured in front of the receiver is 75 K in almost double sideband tuning at 220 GHz LO. At the same frequency the SSB noise temperature is about 95 K with about 20 dB rejection of the upper sideband. G1 receiver SSB noise temperature (SSB tuning) and DSB noise temperature (DSB tuning) are presented in Fig. 3. Upper sideband rejection in SSB mode of operation is presented in Fig. 4. The G1 receiver is thus in a correct state and may be used in SSB mode with rejections higher than 10 dB.

IRAM 0.8 mm receiver at 30-m Telescope

Receiver design

The heterodyne receiver consists of a superconducting tunnel diode mixer mounted with a first intermediate frequency amplifier at the 4 K stage of the liquid helium Infrared Laboratory cryostat, of an ambient temperature second IF amplifier, and of a local oscillator. Local oscillator power is injected in the waveguide mixer input port through a cooled waveguide coupler. The mixer operates in the whole receiver band without any tuning, the only tunable part of the receiver being the local oscillator.

SIS mixer design

The goal of this mixer design was to obtain fixed-tuned operation around 345 GHz (280-370 GHz band). It is a single backshort waveguide mixer. In the mixer block the waveguide height is reduced to a quarter of the standard size. In this mixer two 1–square micron connected seriesly Nb–Al oxide–Nb junctions, with RwC=6, have been used. The individual inductive tuning elements are integrated with the junctions. A new version of a non contacting backshort has been developed for the reduced height waveguide mixer block. A magnetic field is applied to the junctions in order to suppress the Josephson current. Measured mixer DSB noise temperature is 10 K ($0.6h\nu/k$ level). According to this data the mixer sensitivity may be estimated as one photon. During the test the mixer backshort, once fixed, remains in the optimal position. For this backshort position the receiver exhibits a low noise operation across the 30% band.

Receiver test

The receiver equivalent noise temperature has been determined in the standard hot and cold loads experiment in front of the receiver. The best receiver sensitivity has been achieved at the telescope (2850m altitude) where the physical temperature of the mixer was 4.2 K, about 0.5 K lower than in the laboratory at sea level. At the telescope the cold load temperature drops, with the liquid nitrogen temperature, to 75 K. For noise measurements, the output receiver power is integrated over the whole IF band (500 MHz wide). The best measured value of the Y factor in this experiment was about 3. It corresponds to a receiver noise temperature of 30 K (1.9 $h\nu/k$ level). Expressing this noise (or sensitivity) in photon numbers we get down to the four–photon level. Minimum fixed tuned receiver DSB noise temperatures are presented in Fig. 5. In Fig. 6 the receiver sensitivity is given in photons. The black parts of the curves in these figures correspond to the frequencies supported by the existing LO remote control unit (this year the band available for the observations was 320-360 GHz). For the other frequencies the local oscillator has been tuned manually.

An example of the receiver DSB noise behavior in the intermediate 1250-1750 MHz frequency band is given in Fig. 7 for the 325 GHz LO. This curve was measured at the radio telescope with the autocorrelator backend, and with the calibration loads directly in front of the receiver. The steps in the curve are due to slight differences in the noise behavior of the correlator units. The mid–band DSB noise temperature is about 32 K in this measurement, and

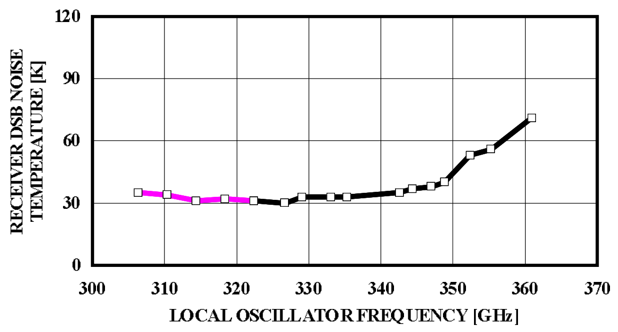

Figure 5: Receiver DSB noise temperature. The frequencies in the black part of the curve are available with the present LO remote control. Noise temperature is measured immediately in front of receiver.

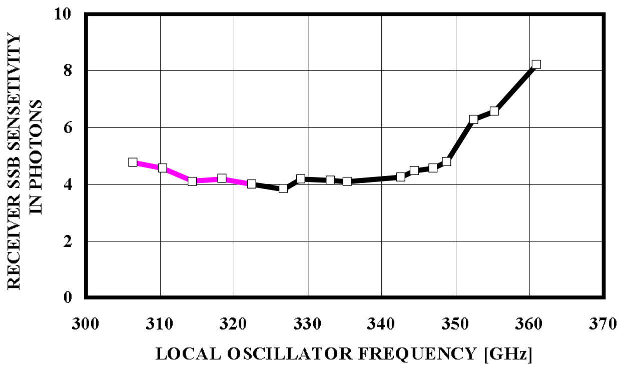

Figure 6: Receiver sensitivity in photons.

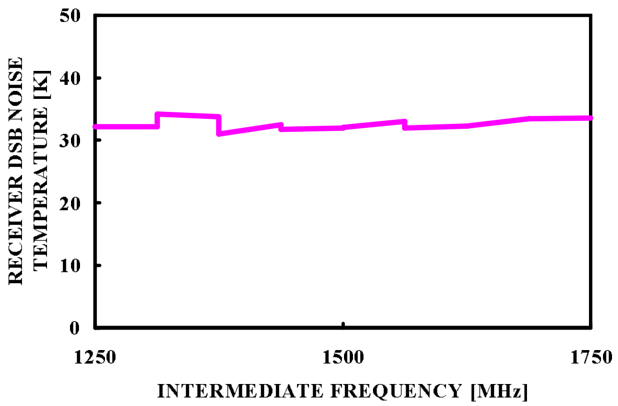

Figure 7: Receiver DSB noise temperature in the 500 MHz IF band, measured with the autocorrelator

the receiver noise in the 500 MHz IF band is rather constant (variation of $\sim \pm 1$ K). The output power stability is better than 0.1% over timescales of 1s. The spectrum of low frequency instability in the IF power is clean (no periodical modulation, with the exception of 50 Hz).

Receiver operation at the 30m radiotelescope

This receiver has been used for observations at the 30m telescope on February 1–15, 1994. The 30m telescope is equipped with a multiplexing quasi optical system for parallel observation in 3 frequency bands. It was possible to operate in parallel in the 0.8 mm, 1.3 mm and in 3 mm bands. The telescope system noise temperature in the 0.8 mm band is strongly dependent on frequency, weather and the telescope orientation. The best SSB system noise temperature during the observation period was 500 K at 330 GHz when the opacity was about 0.17. When the automatic calibration loads are used for the measurements of the receiver noise the losses between the receiver and the standard reference plane have to be taken into account. The noise temperature measured in the reference plane of automatic calibration ($T_{\rm ref}$) may be 30–40 K higher than the receiver noise temperature due to the 10% loss in the multiplexing system. Fig. 8 gives a sample result: the ^{13}CO(3-2) transition spectrum in IC 342, measured with the new receiver at the telescope.

Acknowledgements. The construction and installation of the new G2 mixer and of the 345 GHz receiver benefited from valuable support from several members of IRAM's technical staff, among whom : M.Voss and D.Billon for the fabrication of the junctions, J.L.Orecchia and J.Sendra for the machining, J.Blondel, C.Boucher, and J.Y.Chenu for the cryogenics and support of laboratory tests, and H.Hein for the on-site installation and tests.

Alexandre KARPOV

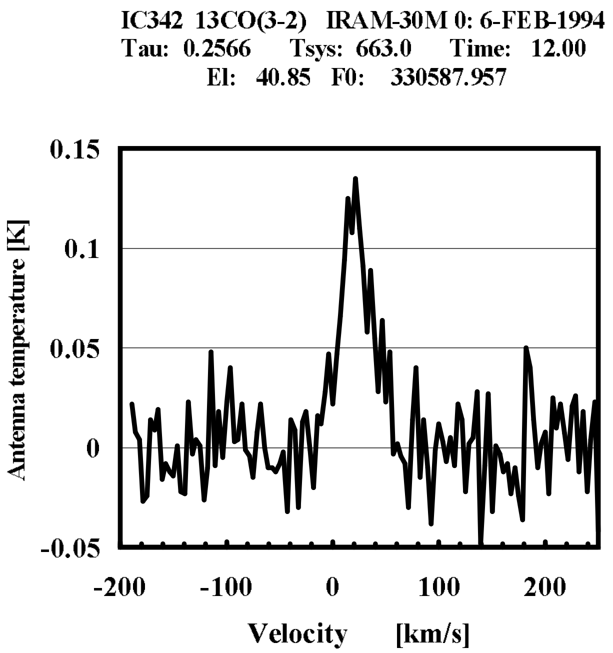

Figure 8: The ^{13}CO(3-2) transition spectrum of the galaxy IC 342 measured with the new receiver at the telescope (by courtesy of Andreas Schulz et al.)

TEST OF POLARIMETER

In the previous Newsletter, the construction of a polarimeter for measurement of circular polarization at 113.3 GHz (CN) was announced. This polarimeter was tested at the 30-m telescope during the period 22–26 February 94 by a commissionning team comprising R. Crutcher, D. Fiebieg, B. Lazareff, G. Paubert, T. Troland.

The polarimeter consists of a dielectric $\lambda/4$ transmission plate, whose design was optimized by J.Lamb. The plate can be rotated between position angles of $\pm 45^o$, thanks to a mechanical device designed by J.L. Pollet. The phase time used was either 1 or 2 seconds, and the blanking time 0.25 second. The polarimeter adds $\simeq$10 K to the receiver noise. It was found that, by tilting the plate, the standing wave ripple could be reduced to a negligible amount.

The main purpose of the test was to investigate the polarization properties of the telescope; specifically the so-called *squint*. To first order, the beams of the telescope in R and L circular polarization are expected to have a slight pointing offset.

The effect has indeed been detected in several different experiments, and the clearest illustration is shown on Fig. 9. This is a map of Venus in Stokes V, the difference of intensity between the R and L signals. It shows, as expected, the difference pattern of two slightly offset beams. In the units of that map, Venus is 21000 units. The observed "butterfly" pattern coresponds to a $0.27''$ squint between the R and L beams, i.e. slightly more than 1/100 of the FWHM.

The frequency dependence of the beam squint was also investigated, to check against possible fine structure in frequency caused by standing waves. It was found to be present, reproducible, but quite small.

A detailed report in being prepared, and will soon be available on request.

Bernard LAZAREFF

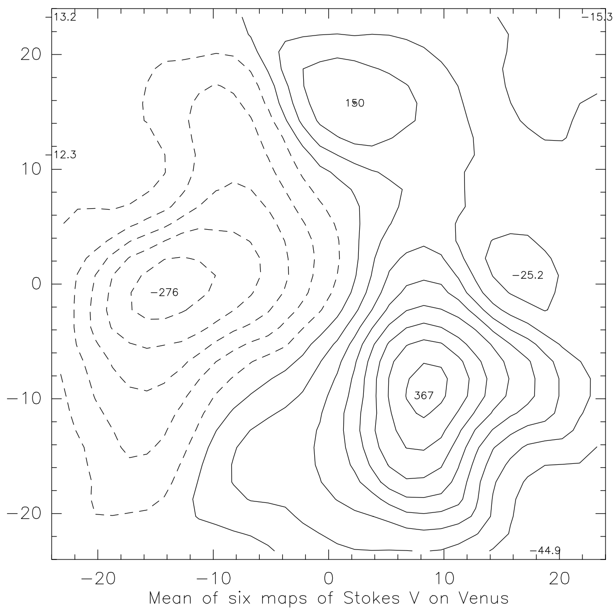

Figure 9: The map of Stokes parameter V obtained on Venus.

Interferometer

OBSERVING PROJECTS

Good weather periods allowed to considerably reduce the backlog of projects which had accumulated in the last months. Half of the A projects are completed, and only one configuration is missing for the second half. Some A/B projects have been started, and there is a good hope to complete most A/B and some B projects before mid-May. However, projects requiring long baselines may not be feasible, and some sources are entering the sun avoidance period.

DATA REDUCTION

REMINDER: because of an offset in the phase lock loop which was not compensated for in the software, old spectral correlator data are shifted by 97.656 kHz. Velocities must be corrected downwards (blueshifted) for LowerSideBand, upwards (redshifted) for UpperSideBand.

REMINDER: Improved computer facilities in Grenoble allow several data reductions to be carried out simultaneously. Investigators are requested to contact S.Guilloteau to schedule the data reduction in Grenoble.

CLIC: Users of CLIC who have a copy of the software at there home institutes are warned that the UV table creation was bugged in releases earlier than FEB94. They should get the FEB94 release.

In Newsletter number 12, a "Call for interest" was issued about the opportunity to carry on a second workshop on PdB data reduction since the first (and so far only) one was carried out already 3 years ago. I am somewhat disappointed to report that I did not receive a single answer.

Stéphane GUILLOTEAU

Software

Unix

A new version of the IRAM/Observatoire de Grenoble GILDAS software has been released February 15, 1994. As announced in the OCT93 release, this FEB94 release no longer provides support for the "old" versions of GreG, Class, Overlay and other programs based on the "old" graphic library. These versions have all been superseded by versions based on a multi-window graphic library. This is a major release, implying that users who had written code using the GILDAS software may have to implement a few modifications to relink their code.

The code is available through anonymous ftp on `iraux2.iram.fr` under directory `dist/soft/feb94`.

VMS

Gilles Duvert from the Observatoire de Grenoble has ported the latest GILDAS software under VAX/VMS. The whole software except CLIC and related tasks is included in this VMS version.

The code and executables are available in compressed backup form and with installation instructions through anonymous ftp on `iraux2.iram.fr` under directory `dist/soft/vms`.

This is a major release, implying that users who had written code using the GILDAS software under VMS have to implement a few modifications to relink their code.

Caution: This is a VAX version which will most likely not run on Alpha machines.

Stéphane GUILLOTEAU

Interfaces to other software packages

We often wish to combine observations from different spectral regions to understand the structure and physics of various objects, and a big step in frequency often means a software change. To do arithmetic with maps from different ends of the spectrum or to avoid creating macros for the same plot in several different languages, data format conversion is necessary. Most of these problems can be solved by converting the data to FITS format, but this is cumbersome and may take a lot of disk space. Direct interfaces would be more practical.

Two interfaces to the GILDAS ".gdf" format have now been created for ESO MIDAS ".bdf" image files (optical and near IR observations) and IDL (Interactive Data Language, a commercial multi purpose package, which some reduction programs use). MIDAS has been available at IRAM for several years, IDL was tested at the institute at the end of last year and will be coming soon.

The first of the interfaces is GREMLIN, which is the GREg Midas LINk. It is possible to read and write MIDAS image and descriptor data with it. GREMLIN uses the SIC command monitor and "hijacks" as many SIC based languages as possible, i.e. GRAPHIC, GREG, GTVL, VECTOR and TASK on Unix. The only limitation is due to conflicts if too many link-libraries are combined (attempts to capture CLIC, CLASS and ASTRO failed). A VMS version of GREMLIN is in preparation. Some commands working on SIC variables have been included, for example a multi-purpose fit algorithm (which will be included into SIC in the near future), a copy command to save the content of a variable into another, a hard delete command and a lot more. See the table below for details.

For IDL, a routine named "gildas.pro" has been written that can read ".gdf" files (with the header). An output option is in preparation but hasn't been tested yet. Interfaces for MIDAS file input/output exist already for IDL (by Stephen A. Voels, USM/DAN) that allow to read and update image and table data. The syntax for their use will be displayed when they are called without argument: mid_rd_image.pro, mid_up_image.pro, mid_rd_table.pro, mid_up_table.pro, mid_rd_dirdsc.pro

For questions and problems concerning GREMLIN and gildas.pro, please contact Michael Bremer (bremer@iram.fr).

Michael BREMER

Table 1: List of commands available in GREMLIN.

```
                  MID\ Language Summary
MINFO    : Display a short introduction into GREMLIN
MCLOSE   : Close MIDAS file
MCOPY    : Create a copy of a SIC variable
MDELVAR  : Delete a program defined variable
MFIT     : Fit a function y=f(x) to SIC variables (any dimension)
MHELP    : Provides online-help with recallable commandlines
MINMAX   : Estimate extrema of SIC variable
MINSERT  : Insert one SIC variable into another
MLOAD    : Load 2D MIDAS file into RG
MLUT     : Load MIDAS color table (optional color table saving)
MOPEN    : Open MIDAS image file
MRAN     : Fill an existing SIC variable with random values
MREAD    : IMAGE, DESCRIPTOR, GROUP : input from MIDAS .bdf files
MROTATE  : Rotate a SIC variable in 90 degree steps
MSET     : FILE, LUT          : Set automatic case conversion for filenames
MVARD    : Get the descriptor of a SIC variable
MWRITE   : IMAGE, DESCRIPTOR  : Output in MIDAS .bdf file format
```

Scientific Results

THE C/O ABUNDANCE RATIO IN THE DETACHED CIRCUMSTELLAR ENVELOPES AROUND CARBON STARS

V. Bujarrabal, J. Cernicharo
Centro Astronómico de Yebes (IGN), Apartado. 148, 19080 Guadalajara, Spain

Abstract: We present molecular observations of a sample of five 'detached envelopes' surrounding C-rich evolved stars: S Sct, TT Cyg, U Ant, U Cam and R Scl. The observed lines are ^{12}CO J=2-1, HCN J=1-0, HNC J=1-0, SiS J=5-4, HC_3N J=10-9, CN N=1-0, CS J=5-4, SiO J=3-2, SO J_N=6_5-5_4, and ^{13}CO J=2-1 (observations from the literature, including results for the lines ^{12}CO J=1-0, CS J=3-2 and SiO J=2-1, are also taken into account). We confirm the presence of two emitting shells in S Sct and TT Cyg. We also find a two-shell structure in U Cam and argue that the envelope of R Scl detected in molecular emission is also probably detached. The (very probable) detection of HCN emission from the inner envelope of S Sct and its unexpected two-peak structure are remarkable. In the inner shells of S Sct and U Cam and the outer shells of U Cam and R Scl, the chemistry is found to be dominantly C-rich, from the comparison of the line intensity ratios with those usually found in standard evolved stars. We note the lack of detected molecular emission, other than CO lines, from the outer envelopes around S Sct and TT Cyg, for which we cannot conclude about the dominant chemistry. We have then not found any sign of O-rich chemistry in the observed detached shells around C-rich evolved stars.
Accepted by Astronomy and Astrophysics.

New Preprints

The following preprints are available from IRAM:

314. The C/O abundance ratio in the detached circumstellar envelopes around carbon stars
V. Bujarrabal, J. Cernicharo
1994, *Astron. Astrophys.*

315. On the question of dark matter and cold H_2
T.L. Wilson, R. Mauersberger
1994, *Astron. Astrophys.*

Programs Scheduled on the 30-m Telescope in 1993

Date	Ident.	Title	Freq. (GHz)	Authors
Jul 6 - 20	96.93	Dense molecular matter associated with the FU Orionis stars RN01B/1C in L1287: 30m observations to complement PdB data in uv plane	96, 115, 144, 220	Guilloteau, Lazareff, Le Floch
	95.93	The circumstellar disk and the outflow of the FU Ori star Par 21	109, 115, 220, 230	Le Floch, Lazareff
	97.93	Support mechanisms and protostellar collapse in cometary globules	97, 110, 220, 230	Le Floch, Lazareff, Gonzalez-Alfonso, Cernicharo
	67.93	Multiline study of dense molecular gas in Arp 220	86, 95, 111, 134	Radford, Solomon, Downes
	89.93	CO observations of detached envelopes around M stars	115, 230	Loup, Waters, Ziljstra, de Jong, Nyman
	8.93	High density gas in early-type galaxies	88, 89, 146, 230	Wiklind, Henkel
Jul 20-Aug 3	80.93	L1221 : A dense clump laboratory	86, 99, 178, 219	Muders, Schmid-Burgk
	64.93	Mm continuum flux measurements of the 16 detected CGRO sources	90, 150	Steppe, Reuter
	92.93	Search for SO^+ in molecular clouds	115, 162, 208, 255	Fuente, Cernicharo, Cox, Guélin
	35.93	What triggers the starburst in NGC2146 ?	115, 230	Greve, Reuter, Sievers
	87.93	Search for SO^+ in circumstellar envelopes	115, 162, 208, 255	Cernicharo, Omont, Guélin, Lucas
	94.93	Search for SiC in shocked molecular clouds	81, 157, 236	Cernicharo, Martin-Pintado, Bachiller
	91.93	Investigation of the streaming motions in the SW part of M31	115, 230	Neininger, Guélin, Wielebinski
	256.92	HNCO as a tracer of gas shocked by the explosion of SgrA-East	87, 88, 153, 219	Zylka, Schilke, Roueff
	287.92	CO photodissociation at the edges of IRC+10216	110, 115, 220, 230	Guélin, Cernicharo, Omont
Aug 3 - 17	91.93	Investigation of the streaming motions in the SW part of M31	115, 230	Neininger, Guélin, Wielebinski
	14.93	Newly discovered proto-planetary nebulae	115, 230, 110, 88	Garcia-Lario, Bachiller
	39.93	A CN survey of galaxies	113, 110, 226, 88	Schilke, Brouillet
	78.93	Chemistry of a photon-dominated region : M17SW	113, 218, 99, 128	Lepine, Benayoun, Warin, Gruenwald
	47.93	Search for water maser emission in starburst galaxies	157, 101, 97, 94	Combes, Casoli, Gerin, Encrenaz, Rieu
	46.93	Molecular clouds in the outer parts of galaxies	115, 110, 220, 230	Combes, Casoli, Garcia-Burillo
	25.93	Search for galactic plane corrugations in warped galaxies	115, 230	Gomez de Castro, Garcia-Burillo, Florido, Battaner, Pudritz
Aug 17 - 31	81.93	Carbon isotopes in the molecular envelopes of evolved stars	92, 98, 138, 145	Kahane, Forestini, Forveille, Guélin, Cernicharo
	90.93	High resolution observations of CO emission in the envelopes of evolved stars : a key to the ultimate evolution of the stars with high mass loss	115, 230	Lucas, Neri, Guélin, Guilloteau, Kahane, Loup, Forveille, Omont
	82.93	Nitrogen and oxygen isotopes in the molecular envelopes of evolved stars	86, 219, 220, 224	Kahane, Forestini, Forveille, Guélin, Cernicharo
	K003	Small scale structure of pre-star forming clouds		Falgarone, et al.

Date	Ident.	Title	Freq. (GHz)	Authors
Aug 31-Sep 14	K003	Small scale structure of pre-star forming clouds		Falgarone, et al.
	72.93	A search for Si_2C in IRC+10216	88, 103, 145, 96	Martin, Henning, Koempe
	187.93	CO distribution in the interacting active galaxy NGC 7674	111, 224	Moles, Marquez, Cernicharo
	124.93	High angular resolution study of molecular chemistry towards photodissociation regions (PDRs)	87,90, 97, 226	Fuente, Martin-Pintado, Rodriguez-Franco
	71.93	Millimeter hydrogen recombination line emission from AGNs and stars	92, 146, 221, 231	Strelnitski, Smith, Martin-Pintado, Matthews, Thum
	22.93	Kinematics and dynamics of the ringed spiral NGC 7331	114, 229	Wielebinski, Von Linden, Reuter, Braine, Brouillet
	79.93	New features in the recombination line maser in MWC349	120, 147, 231	Thum, Bachiller, Martin-Pintado
	74.93	H_2CO in the circumstellar disk of Sgr A	140	Wilson, Pauls, Johnston, Lemme
	26.93	Measuring the He/H gradient in our galaxy : a combined IR and radio technique	135, 106	Megeath, Herter, Stolovy, Wilson
	33.93	The column density of CO toward Zeta Ophiuchi	115, 230	Wilson, Mauersberger, Dahmen, Lemke
	189.93	Where have all the molecules gone ?	218, 144, 239	Wilson, Mauersberger
	174.93	CO observations of the X-ray absorbed elliptical galaxy NGC 4472	114, 229	Helfer, Blitz
	117.93	Abundance, excitation and isotopic variation studies of ^{12}CN, ^{13}CN, and $C^{15}N$ in Orion A and B	108, 113, 220, 226	Simon, Stutzki
Sep 14 - 28	26.93	Measuring the He/H gradient in our galaxy : a combined IR and radio technique	135, 106	Megeath, Herter, Stolovy, Wilson
	32.93	The H_2 column density toward Cas A	110, 220, 109, 218	Wilson, Gaume, Johnston
	189.93	Where have all the molecules gone ?	218, 144, 239	Wilson, Mauersberger
	164.93	CO observations of the galaxy NGC 4501	114, 228	Bosma, Van Gorkom, Athanassoula
	165.93	The opacity of galactic disks	115, 230	Bosma, Athanassoula
	160.93	Physical properties of the major asteroids	90, 150	Altenhoff, Johnston, Stumpff, Webster
Sep 28-Oct 12	120.93	Studies of cold molecular gas	110,114,230	Lequeux, Allen
	134.93	CO abundances in the outer galaxy	109,110,115,230	Wouterloot, Brand
	153.93	CO in the Mice	112, 225	Casoli, Combes
	131.93	High velocity gas expelled out of the ring galaxy Karachentsev 29	109	Horellou, Combes, Casoli