# IRAM Newsletter

Number 22 July 7, 1995

## Calendar

**September 4th, 1995:** Deadline for the submission of observing proposals for the period Nov. 15, 1995 to May 15, 1996.

**December 7-8th, 1995:** IRAM User Meeting in Grenoble, France.

**December 11-13th, 1995:** ESO/IRAM/NFRA/OSO Worshop on Science with Large Millimeter Arrays, Garching, Germany.

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## 30m Telescope

### New telephone and fax numbers for IRAM Granada and Pico Veleta

Due to technical reasons the telephone and fax numbers of both the IRAM Granada office *and* the 30m telescope have to be changed. The new numbers will be effective after 13 July 1995 for the 30m telescope, and 18 July 1995 for the Granada office. The old telephone and fax numbers *will not work after these dates* (there will be a recorded message, however). The Granada office will have only one telephone number with three lines connected. The new numbers (from outside Spain) are the following:

- **30m telescope Pico Veleta** (after 13 July 1995):
  - **Tel. +34-58-48 80 00**
  - **Fax +34-58-48 80 82**
- **IRAM Granada office** (after 18 July 1995):
  - **Tel. +34-58-22 88 99**
  - **Fax +34-58-22 23 63**
- From inside Spain the +34 is replaced by 9, and from inside Granada, the +34-58 is dropped.

Please make sure to update telephone lists, memory dialing in telephone exchanges and fax machines etc.

### 3 mm receiver under remote control

The 3 mm SIS receiver is now remotely tuned from the control room. This makes tuning much faster, it takes about 6 minutes to change the frequency (without measuring the image sideband rejection). The tuning range has been expanded at the lower end: sky frequencies can now be tuned from 81 GHz to 115.3 GHz.

### Frequency switching with 3 receivers possible

In Newsletter No. 19 (January 1995) we reported on the availability of the frequency switching observing mode at the 30m telescope. The article described several limitations, one of which has been overcome now.

Until recently the software did not allow the simultaneous use of more than 2 receivers for frequency switching. This has been changed, and 3 receivers can be used simultaneously. Several observers already used the 3 mm, 1.3 mm G1 and 2 mm receivers in parallel and in frequency switching mode with good results. The 1.3 mm G2 receiver so far has not been used for frequency switching. However, the observer should be aware of a possible problem with the 3 receiver configuration: baselines may be worse than when using only the 3 mm or/and 1.3 mm 230G1 receivers. This is due to the different optics used for three receivers. An additional polarization grid in the optical path may produce poorer baselines.

We would like to remind the potential users of frequency switching of some parameters:

- Maximum usable frequency throw (in velocity units): 45 km/sec
- Usable backends: autocorrelator, 100 kHz filterbank
- Default switching rate: 1.5 sec per phase (shorter times possible for the 100 kHz filterbank alone)
- Efficiency (time on source/total time spent): > 90%

For details about frequency switching see Newsletter No. 19 (January 95) or the IRAM Technical Report 228/95 (Thum *et al.*, "Frequency Switching at the 30m Telescope").

### The Internet Link

We currently use a permanent telephone link at 9600 Baud between IRAM Granada and the University of Granada for our Internet link. In the past we have suffered from several problems (configuration errors, hardware problems, telephone line cuts, ...). The velocity of the current link limits its usage (in particular for file transfer and WWW), and we are testing an ISDN link (64 kBaud) as a replacement of the analog line. However, for the installation we depend on the telephone company TELEFONICA and the support of the organization that runs the andalusian research network.

### The radio link between Granada and Pico Veleta

The link between the two computer networks in Granada and at the 30m telescope is normally done with a microwave link at 64 kBaud. We use the link to connect the two LANs with remote bridges. This implies that Decnet and TCP/IP can be used over this link. Unfortunatly, the radio link broke down in May, and as the manufacturer of the equipment does not exist anymore we have serious problems in getting it repaired. As a backup we use a modem at 19200 Baud. This connection only offers DecNet between Granada and the telescope. Because it cannot be used for TCP/IP there is no direct access to Internet from the 30m telescope at the moment. We have ordered an ISDN (digital) telephone line for the telescope and will use it in the future to link the remote bridges at 64 kBaud.

### Computer access and e-mail to IRAM Granada

Access to the Granada computers is now only possible via Internet. The Internet domain is iram.es, e-mail addresses are of the form *user*@iram.es, where *user* is the person's last name. A WWW-server is available on granada.iram.es (150.214.224.100). The SPAN link is no longer available. PSI is still possible, however computer staff needs to be contacted before using it.

*Wolfgang WILD*

# Interferometer

### New receivers

The intense activity which went on during April (see May 95 newsletter) has been followed by another period of dual frequency receiver installations. The last receiver was installed in less than 48 hours: Antenna 3 was brought in the hall on May 22, 6 h T.U. with the old receiver still working. The same antenna, with the new receiver fully functional was brought out of the hall on May 23 18 h T.U. and fringes (at both frequencies, with 4 antennas) were obtained less than an hour later.

All antennas are now equipped with fully functional dual-frequency receivers. Receiver performance is as expected from the lab, with $T_{\rm rec}$ (DSB) around 40 K, yielding $T_{\rm sys}$ (SSB) about 120 K below 110 GHz, 250 K at 115 GHz and 400-600 K at 230 GHz.

The relative pointing of the 3mm and 1.3mm receivers is within 10″. Further adjustment will probably not be attempted before next winter.

### 230 GHz first image

A first image at 230 GHz has been obtained, despite the unfavorable period of the year. Although it only includes 6 baselines, it clearly demonstrates that the 230 GHz system is fully operational, and shows the promise of what can be expected for next winter.

### Summer maintenance and track extension

Two antennas have gone through their yearly maintenance. Maintenance completion for the other antennas is expected early August. Work has restarted on the track extension, which must be completed this summer.

### New configurations

Because of the advent of the 1.3 mm receivers and of the new stations, the standard set of configurations is being revised. A preliminary list of available configurations is the following:

| Name | Stations | |
|---|---|---|
| D1 | W00 N05 E03 W05 | ([a]) |
| D2 | W10 W01 N09 E03 | ([b]) |
| C1 | E10 W12 N05 N13 | |
| C2 | E10 W09 N03 N15 | (*) |
| B1 | E24 E18 N11 N17 | (*) |
| B2 | E24 W12 W09 N20 | (*) |
| A1 | W27 W20 N30 E24 | (*) |
| A2 | W23 N05 N30 E18 | (*) |

([a])previously called D
([b])added to provide 3″ at 230 GHz

(*) The details of those configurations may be replaced by other choices, offering similar baseline lengths.

### Calibration Software

An automatic calibration procedure has been written and checked on representative data. Although this procedure cannot be expected to solve all problems, it showed up to work quite well on good data and proved to be a useful guide to help checking data quality. We hope that it will help the astronomers by saving some of their time during the data calibration stage.

### VME antenna control and new control computers

A real test of antenna control based on VME interfaces has been successfully performed. One antenna was temporarily interfaced to a VME crate which provided full control over the Azimuth and Elevation drives and encoders. The antenna tracked successfully on astronomical sources; fringes were even obtained with the other antennas.

This test is an important step toward a full replacement on the CAMAC instrumentation and VAX computers by a VME based system connected to a Unix workstation. This replacement is now foreseen for November/December. The new control system will allow more flexibility in the operation of the PdB array, which is essential specially for 1.3 mm observations. Based on our successful experience with the numerous upgrades carried on at Bure this year, we hope that the installation and final tests will not require more than 2 to 3 weeks on the site.

*Stéphane GUILLOTEAU*

## Development of SIS Mixers

### Modelling and design

The achieved progress is based on computer aided modelling of waveguide SIS mixers. The computations have been verified in experiments with scale models and with existing SIS mixers. Model predictions of low-noise, fixed-tuned operation of mixers with new versions of the Nb printed circuits containing SIS junctions and impedance transformers are now confirmed by the performance of the receivers based on the new mixers.

Modelling of sideband rejection in the mixers supports the optimization of the mixer and the SIS junctions printed circuit design with the aim of providing stable, low noise receiver operation with good rejection of the image band.

The SIS mixers consist of a mixer block, a single backshort and an integrated circuit with the SIS junctions printed on the quartz substrate. Being conservative with the mixer blocks, except the 3 mm mixer, we made new designs of the integrated superconductive circuits optimized with the mixer model according to different criteria: coverage of the specified frequency bands, stability of mixer operation, and sideband rejection using a single backshort or a broad band, fixed tuned operation of the mixer.

### Design of integrated circuits with the SIS junctions in 93/94

- 230 GHz. After the first experiments with partial improvement of the integrated circuit in 1991-1992 a completely new circuit was prepared for single sideband operation in the 205 - 245 GHz band with 4 GHz IF.
- 150 GHz. A new Nb circuit, with inductively tuned SIS junctions, was prepared for the 130-180 GHz band. It is optimized for the fixed-tuned operation of an SIS mixer.

### Design and operation of new SIS mixers

- 3 mm SIS mixer. A new version of the mixer block was developed to provide $\sim$ 30 dB rejection of the upper side band in the 80-120 GHz waveguide band. Selectivity of the mixer tuning is due to a fixed E-plane tuner integrated in the block. A single backshort is used for the tuning. Minimum DSB receiver noise with the new SIS mixer in laboratory test is about 26 K. In 1994 new 3 mm mixers were prepared and installed at Pico Veleta and on antenna 4 at Plateau de Bure. Minimum SSB receiver noise measured on antenna 4 is about 44 K.
- 1.3 mm mixer. A mixer with an inductive tuning of the two $2\mu\text{m}^2$ SIS junction was prepared and tested

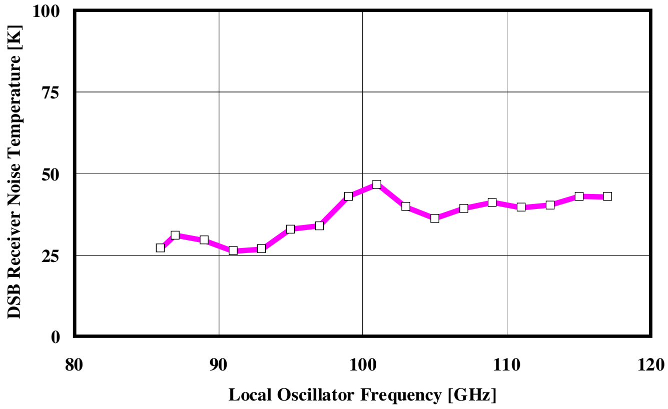


Figure 1: Operation of the new 3 mm SIS mixer prepared for antenna 3 at Plateau de Bure in a laboratory receiver with cooled optics. Minimum DSB receiver noise temperature is about 27 K. With a forward efficiency of 93% at the 15 m telescopes, in good weather condition such receiver still contributes more than 50% of the system noise temperature. Further improvement of the mixer is in progress.

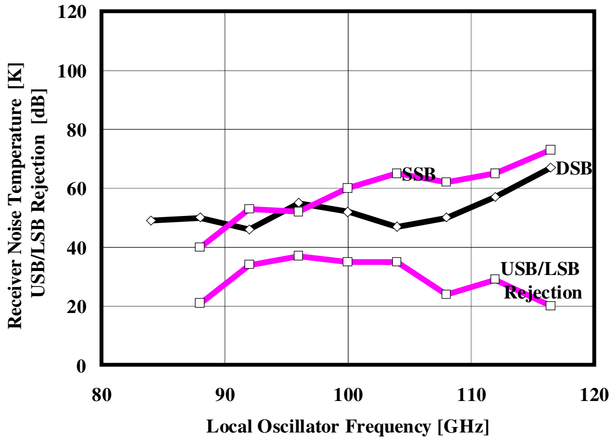


Figure 2: Receiver performance with a new 3 mm mixer with an E plane stub. This is a spare Plateau de Bure receiver with ambient temperature optics and a diplexer for LO injection. Later this mixer was installed in the 30 m telescope receiver.

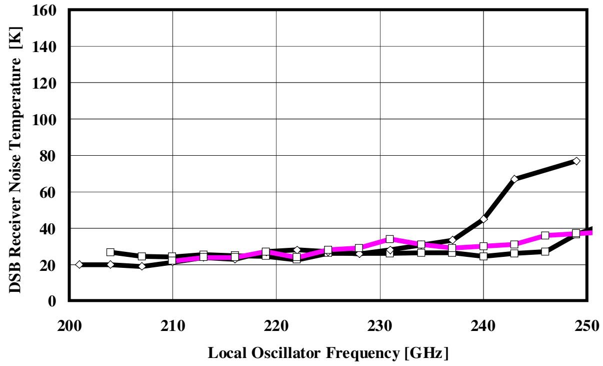


Figure 3: Operation of the receiver with the new 1.3 mm SIS mixers prepared for the dual channels receivers of Plateau de Bure antennas 1-3. Receiver structure is similar to the real receiver: optics is cooled and the local oscillator is injected by a coupler. This is the first design of SIS junctions with the fully optimized integrated circuit.

during 1994. With a 4 GHz IF this mixer tuning gives 18 dB image rejection over all the 1.3 mm receiver band in a good accord with the model prediction. A mixer with this performance was prepared for Pico Veleta G2 receiver early in 1994. The Plateau de Bure receiver 1.5 GHz IF is relatively lower and the image band rejection is not so efficient. Four mixers were prepared for the new generation of the Plateau de Bure receivers. Receiver DSB noise temperature with the new mixers may be as low as 20 K, never achieved at this wavelength before.

– 2 mm mixer. This mixer with instantaneous bandwidth 125 - 180 GHz was developed in 1993-1994. In the laboratory the DSB receiver average noise temperature is about 25 K and the minimum DSB receiver noise temperature is about 20 K. It is one of the best 2 mm receiver sensitivities at present.

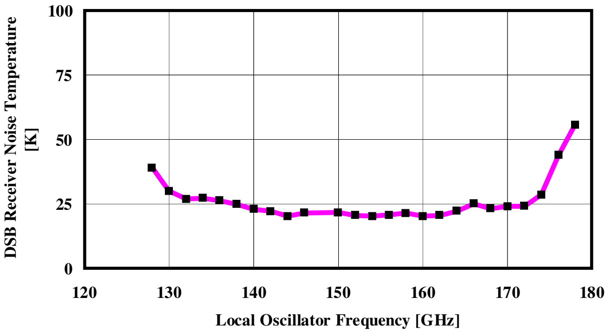


Figure 4: New, fixed tuned 2 mm mixer in a cooled optics laboratory receiver gives a DSB receiver noise about 20 K.

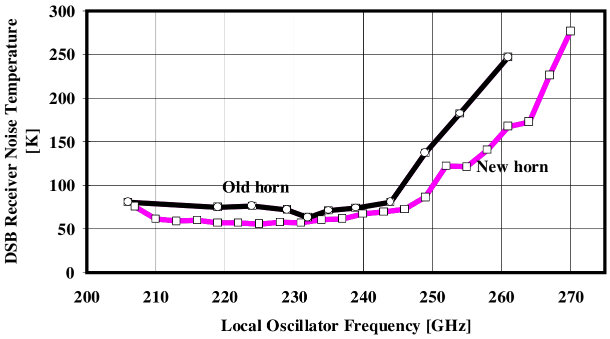


Figure 5: Status of the 230 GHz G2 receiver at Pico Veleta after installation of the new SIS mixer in February 94 and after the change of the horn in January 95. The receiver band is improved by 10 GHz. The noise temperature is measured in front of receiver.

### Operation of a SIS mixer with full NbN junctions.

As known, the principal frequency limit to SIS mixer low noise performance is given by the gap frequency of the superconductor. In theory SIS junctions may be used up to twice the gap frequency. In practice, mixer operation degrades just at the gap frequency due to the increase of the loss in the superconductor. With the introduction of NbN technology at IRAM, the frequency limit of the devices may reach about 1300 GHz, the gap frequency of NbN, instead of the 700 GHz of Nb. Another reason for introducing the new material is the possibility of simplifying the receiver cryogenics, using the NbN SIS mixer circuit at a temperature higher that 4.2 K.

We demonstrate for the first time low noise receiver operation with a full NbN integrated circuit with SIS junctions in the mixer. Using the NbN-MgO-NbN junction technology developed in our institute, a full NbN circuit was developed and tested at 150 GHz. Special attention was paid to achieve high tolerance to the junction parameters. Even with a junction with $R_{\mathrm{N}}\omega C$ of about 50, we arrive at 65 K DSB receiver noise temperature. The mixer with the NbN circuit was at 5.6 K. With improvement of NbN junction technology, we may expect a further reduction of the NbN mixers noise, down to the noise of Nb devices.

### Submillimeter mixer with SIN junctions.

A mixer with a SINS Nb-Al oxide-Al-Nb quasi-particle tunnel junction was prepared for the 0.87 mm band. This type of junction is nearly free of pair currents and related perturbations. Potentially having a better stability of operation, this mixer works without the magnetic field normally used at submillimeter wavelengths to suppress pair currents. We achieve a receiver DSB noise temperature of about 130 K at 310 GHz. Note that this receiver noise was reached with enormous junction $R_{\mathrm{N}}\omega C$, about 30 times more than optimum. With improvement of the SIN junction technology, receiver noise with an SIN mixer may be about twice the noise of the SIS receiver.

### Status of the 230 GHz G2 receiver at Pico Veleta

After installation of the new SIS mixer in the G2 receiver at the 30m telescope with improved receiver noise and sideband rejection in the 205-250 GHz band, many observing requests were made to observe outside the nominal frequency range. The frequency limitation had been partly imposed by the horn integrated with the mixer. We present in figure 5 the status of the G2 receiver both with the old horn in February 1994, and after the change of horn in January 1995. The receiver noise is measured with the reference plane in front of receiver.

*Alexandre KARPOV, Jacques BLONDEL*

# Call for Observing Proposals on the 30m Telescope

The *next deadline* for the submission of observing proposals for the IRAM 30 m telescope is September 4th, 1995, midnight. The observing session will extend from Nov. 15th, 1995 to May 15th, 1996 and cover roughly the 'winter' period at Pico Veleta. Three types of proposals will be considered:

- *i*) proposals at 3 mm, 2 mm and 1.3 mm wavelength using heterodyne receivers,
- *ii*) proposals at 0.8 mm wavelength using a heterodyne receiver (to be scheduled during a 2-week observing session),
- *iii*) proposals at 1.3 mm wavelength using a bolometer. The bolometer will be the 19 channel array (or 7 channel backup) belonging to the MPIfR.

In total, roughly 3000 h of observing time will be available. This should allow to schedule at least some bigger programmes needing in the order of 100 hours (or even more). No new call for 'key programmes' is issued for the session.

The 30-m telescope efficiency is low at 0.8 mm ($B_{\rm eff} \simeq 25\%$) and the power radiated in the error beam is twice larger than in the main beam. Pointing can also be marginal at this short wavelength in case the atmosphere is unstable.The 0.8 mm proposals should discuss the effect of the error beam and of pointing errors on the observations.

Please, find below some relevant information as well as a copy of the proposal form.

## News

Recent improvements in hardware, software and mixers have made possible frequency switching with satisfactory baselines. Several limitations exist e.g. in terms of frequency throw (max. 45 km/s), backends, phase times etc. For details see [8]. Frequency switching is now open for public use. The receivers 3 mm, 230G1 and 2mm can be frequency switched simultaneously. However, baselines may be better when only using the 3 mm and/or the 230G1 receiver(s) due to the different optical setup.

An instantaneous IF bandwidth of 1 GHz will be available for the 230G2 receiver on an experimental basis. The two 1 MHz filterbanks (512 MHz each) can be combined to provide 1 GHz bandwidth. The use of the 1 GHz wide filterbank excludes the simultaneous use of any other backend with the 230G2 receiver (the other receivers are not affected). The setup for 1 GHz bandwidth is being prepared, and progress will be announced in the Newsletter.

A second 3 mm receiver (3mm2) is being built presently and should be operational this fall. It will be usable simultaneously with the present 3 mm receiver (3mm1) and, with some extra losses, with 230G1 and 230G2. Its performance is not yet known, but should be similar to that of 3mm1. Since we have so far no experience with 4-receiver operation, this new receiver should normally not be considered in the telescope time calculations.

Most proposals submitted for the 30 m telescope underestimate the observing time needed to carry out the programme, even under excellent weather conditions. We ask you to pay special attention to this matter *as time underestimation is now a major criterion for proposal rejection* (several programmes were rejected in April by the Program Committee on that ground). A technical report has been issued to help you to this matter [9]. You may also ask for IRAM's assistance (but well before the deadline!).

The 19-channel MPIfR bolometer, which was installed in March 1995 on the 30-m telescope, will again be available this winter for $\approx 4$ weeks, presumably during February/March. This bolometer showed excellent performances during last year's observing run.

Finally, to help us keeping up a computerized source list, we ask you to fill in your 'list of objects' as explained below.

## Applications

Your applications should be addressed as usual to:

IRAM Scientific Secretariat,
300 rue de la piscine,
F-38406 St Martin d'Hères, France.

All proposals should have *reached* the Secretariat by September 4th, 1995, midnight. (Proposals sent by Fax will be accepted, provided they arrive by that time in a readable form; Fax (33) 76 42 54 69). Except for a duplicate of the source list (see below), no proposal should be sent by e-mail. You (i.e. the Principal Investigator) will receive by return mail an acknowledgement of reception and a proposal number.

To avoid the allocation of several numbers per proposal, send *only one* copy of your proposal, either by mail or by fax. In case your fax reaches us in time, but incomplete or unreadable, we will try our best to contact you (your responsibility, however).

Your proposal will only be evaluated if submitted in the correct format (these forms are available by anonymous ftp from `iram.fr` in directory `dist/proposal`, as well as a Latex style file `proposal.sty`; or with the World Wide Web al URL `http://iram.fr/www/iram.html`). Do not use characters smaller than 11pt, which would make your proposal unreadable if we had to fax it, e.g. to the members of the P.C.

On the title page, you must fill out the line 'special requirements' if you request the polarimeter, 'service observing', or specific dates for time dependent observations (if there are periods when you cannot observe for personal reasons, please specify them here; beware, however, that they could be a motive for proposal rejection!).

We *insist* upon receiving, with proposals for heterodyne receivers, a complete list of frequencies *corrected* for source redshift (to 0.1 GHz, unless your frequencies are confidential). You should specify which receivers you plan to use. *Note that the use of the 2 mm receiver prevents the use of the second 3 mm and 1.3 mm receivers, which, otherwise, can be used in parallel with receiver 3mm1 and 230G1 (see below).*

In order to avoid useless duplication of observations and to protect already accepted proposals, we keep up a computerised list of targets. We ask you to fill out carefully your source list. This list must imperatively contain *all* the sources you plan to observe during the coming session and *only those* for which you actually request observing time. To allow electronic scanning of your source parameters, your list must be typed or printed following the format indicated on the proposal form (please, *do not hand write*). If your source list is long (e.g. more than 15 sources) you may print it on a separate page, *keeping the same format.*

The scientific aims of the proposed programme should be explained in 2 pages of text *maximum*, plus one page of figures and tables. Proposals should be self-explanatory, clearly state these aims, and explain the need of the 30m telescope. The amount of time requested should be carefully estimated and justified (see below); it should include pointing, focussing, and calibration checks and allow for receiver tunings (on average 20 min. per receiver).

A scientific project should not be artificially cut into several small projects but should rather be submitted as one bigger project, even if this means 100–150 hrs.

If time has already been given to one project but turned out to be insufficient, explain the reasons, e.g. indicate the amount of time lost due to bad weather or equipment failure; if the fraction of time lost is close to 100%, don't rewrite the proposal, except for an introductory paragraph. For continuation of proposals having led to publications, please give references to the latter. *In all cases, indicate on the first page whether your proposal is (or is not) the resubmission or the continuation of a previously submitted 30 m telescope proposal.*

## Observing time estimates

Observing time estimates must take into account:

- receiver tunings,
- pointing, focus, eventually necessary receiver alignment, continuum and line calibrations,
- telescope motions when changing sources as well as dead times due to telescope motion and/or data writing between ON and OFF subscans,
- integration time on source and comparison field(s). The total integration time should be derived using the standard formula:

$$\Delta T_{MB} = \frac{\eta_{\rm F}}{\eta_{\rm B}} \frac{2T_{\rm sys}}{\sqrt{Bt}}$$

where $\eta_{\rm F}$ and $\eta_{\rm B}$ are the telescope forward and main beam efficiencies, $T_{\rm sys}$ is the system temperature above the atmosphere (in the antenna temperature scale), $B$ the channel noise bandwidth, and $t$ the total (ON + OFF) integration time. $T_{\rm sys}$ should be estimated for an 'average' winter humidity for 3mm, 2mm and 1.3mm observations (4 mm of precipitable water, or $\tau_{\rm zenith} = 0.3$ at 230 GHz) and for 'good' winter conditions (1.5 mm of water, or $\tau_{\rm zenith} = 0.3$ at 345 GHz) for 0.8 mm observations.

*We ask you to specify in your proposal the parameter values ($T_{\rm sys}, \Delta T_{MB}, B$, total integration time, overheads and dead times) adopted in your calculation of the needed telescope time.*

A technical report explaining how to estimate the telescope time needed to reach a given sensitivity level in various modes of observation was published in the January 1995 issue of the IRAM Newsletter [9] [1]. *You are asked to follow the guidelines given in this report (or to justify particular requirements) in your proposal.*

## Long programmes

This observing session offers the opportunity to schedule a few bigger programmes (typically 90–120 h). These 'long' programmes should mostly be centered on 1.3 mm spectral observations and should use at least 10h/day; they should have a large astronomical interest and be well explained. Careful time estimates will be of crucial importance for their acceptance.

## Service observing

To facilitate the execution of short ($\leq$8 h) programmes, we propose "service observing" for some easy to observe (e.g. short, single source) programmes *with only one set of tunings.* Observations are made by the local staff (operators helped by the astronomer-on-duty or by a member of the investigator's institute present at the telescope for his/her own observations). We will try to send you the `spectra.30m` data files and the two pages of the OBS monitor if your computer allows it (Spain, France or Germany only, so far). This is a passive way of observing, no direct interaction with the telescope through OBS being possible. For this type of observation, we request an acknowledgement of the IRAM staff member's help in the

[1] electronically available by anonymous ftp at `iram.fr`, directory `dist/newsletter/jan95`, or via the WWW au URL `http://iram.fr/www/newsletter/`

forthcoming publication. Please, if you are interested by this mode of observing, specify it as a "special requirement" in the proposal form (IRAM will decide which proposals will actually go to that mode).

## Programmes for the May – Nov. 1995 period

A total of 85 proposals were submitted for the deadline of February 1995. 31 proposals were rated "A", 30 "B", the others "C" or "D". All the "A" and about half of the "B" programmes will actually get time on the telescope, some, however, with less time than requested. The telescope schedule until mid-August is made; the programme PIs have been or are being notified.

Principal Investigators of accepted proposals receive with the telescope schedule a *Confirmation of Observing Time* form which we ask you to return, properly filled, by Fax to IRAM Granada *and* IRAM Grenoble (Scientific Secretariat, Fax (33) 76 42 54 69, attention Mrs. C. Berjaud). The list of frequencies to be observed (normally, the same as in the proposal) should arrive in Granada at least two weeks in advance. It is also only after we receive your confirmation in Grenoble that we will send out duly signed mission forms to those of you entitled to travel reimbursement.

If you have questions, please contact Mrs. C. Berjaud at IRAM Grenoble.

## Relevant Information about the 30 m Telescope

(Please, see additional information in the IRAM Newsletters and in the internal reports listed below).

### *Receivers*

The IF bandwidth of all heterodyne receivers is 500 MHz. The following table lists the present possible receiver combinations:

| | Rec. Combinations | | | |
|---|---|---|---|---|
| Receivers | 3-Rec. | | | 1-Rec. |
| 3mm1 | * | * | * | |
| 2mmRX | | * | | |
| 230G1 | * | * | * | |
| 230G2 | * | | | |
| 0.8mm-SIS | | | * | |
| Bolo | | | | * |

As soon as ready, the second 3 mm receiver (3mm2) can be used simultaneously with the 3mm1 receiver and/or one of the 230 GHz receivers. Later, we plan to implement 4-receiver operation: 3mm1+3mm2+230G1+230G2.

#### *3 mm SIS receiver*

The tuning band is 81 - 116 GHz; receiver temperatures are between 100 and 140 K, the image sideband rejection is between 25 dB and 30 dB.

The high rejection of the USB improves the system temperature and the calibration accuracy, particularly for 115 GHz observations, for which the receiver image sideband sees the bright oxygen 118.75 GHz atmospheric line.

It is important to check your calibration on strong reference sources (see IRAM line catalog and updates). Beware also of possible interference between the 'second' 1.3 mm receiver, 230G2, and this receiver when operating at harmonic frequencies (the two receivers receive the same polarization; the interference will be a strong and narrow line).

This receiver is also used as the standard pointing receiver.

#### *2 mm Receiver*

Good and reliable performance over most of the band. Tunable from 129 GHz to 180 GHz with SSB; receiver temperatures of 70 to 150 K (130 to 155 GHz), and 150 to 400 K (155 to 180 GHz).

#### *1.3 mm heterodyne Receivers*

– 230G1:

  Operating band: 203.4 – 253 GHz. Between 203 and 245 GHz, the SSB receiver temperature is 100 – 180 K in the standard reference plane. At 253 GHz we have $T_{\rm rec} = 276$ K and 12 dB rejection.

– 230G2:

  The SSB receiver temperature over the nominal tuning range (210–250 GHz) is 100–130 K in the standard reference plane. The upper side band can be rejected by typically $\gtrsim 16$ dB over this range. This receiver can be tuned to 267 GHz, although with a higher noise temperature ($T_{\rm SSB} \sim 600$ K). See the March 1994 Newsletter for more details.

The two 1.3 mm receivers and the 3 mm SIS receiver can be used simultaneously. Beware, however, of possible interference of the 230G2 LO into the 3 mm receiver. *The 230G2 receiver cannot be operated with the 2 mm receiver*, since both receivers use the same control box and polarization. Switching from one receiver to the other is not straightforward. Please specify in the proposal form whether you choose to use the 2 mm receiver or 230G2.

At 1.3 mm (and *a fortiori* at shorter wavelengths) a large fraction of the receiver radiation pattern is distributed in an error beam (which can be approximated by two Gaussians of HPW $\simeq 170''$ and $800''$ — see A&A 274, p.144-146 for more details). Astronomers should take into account this error beam when converting antenna temperatures into brightness temperatures.

*0.8 mm Receiver*

The IRAM 345 GHz SIS receiver will be made available for a couple of weeks; its characteristics are:

- Operating band: $\sim$ 330 GHz - 360 GHz,
- DSB receiver temperature= 100–120 (up to 345 GHz), 130–150 K above,
- $F_{\text{eff}} = 0.75$, $B_{\text{eff}} = 0.25$.

This receiver works only in DSB mode with an IF of 1.5 GHz. It can be operated simultaneously with 230G1 and the 3mm SIS RX (with some extra losses, however).

*The MPIfR Bolometer array*

A bolometer array with 19 channels, built at the MPIfR, will be made available to external users for a period of 3–4 weeks Each channel will have a sensitivity of $\simeq$ 70 mJy $s^{1/2}$ under very good weather conditions and a HPBW of $11''$.

The bolometer will normally be operated by wobbling at 2 Hz the secondary mirror in azimuth. As the array is fixed in Nasmyth coordinates, the orientation of the 19 beams with respect to the sky and to the chopping direction change with elevation. A special software will be made available at the telescope and in Granada for data reduction. In case the 19 channel bolometer would not be available, the MPIfR 7 channel bolometer would be offered.

*Polarimeter*

A polarimeter has been constructed by IRAM for measurements of *circular* polarization. It has been tested on the telescope in February 1994. The results of the test are available in the March 1994 issue of the IRAM Newsletter. The main technical features of the polarimeter are briefly described below.

The polarimeter consists of a dielectric quarter-wave plate working in transmission. It is rotated between two positions at $\pm 45^o$ by a motor, the switching time is $\simeq 0.3s$, and the phase time is adjustable. From the point of view of data acquisition, it functions like other switching devices, i.e. the chopper or the wobbler, and the *difference* between the RCP and LCP intensities is acquired.

The present quarter-wave plate has been designed for 113.3 GHz. Its transmission loss is $\simeq 2\%$, and its cross-polarization below 20 dB. Similar plates could be fabricated for other frequencies if needed. Proposals for projects requiring the polarimeter can be submitted. They should state clearly the degree of performance that they demand from the technical side. Besides the scientific evaluation, the acceptance and scheduling of such proposals will depend on their feasibility as judged from their requirements.

*General point about receiver operations*

We urge observers to restrict their frequency lists as much as possible and to send them early to Granada and Grenoble. For late arrivals (less than 2 weeks in advance), or a large number of frequencies, there is no guarantee for a prior test of the requested tunings.

## *Backends*

There are 6 backends which can be individually connected to any receiver.

- The first 1MHz filter bank, consisting of 512 channels of 1 MHz (can be split into two halves and connected to two different receivers);
- The second 1MHz filter bank, consisting of 512 channels of 1 MHz (not splittable). The two 1 MHz filterbanks can be combined into a 1 GHz wide filterbank and connected to 230G2. This, however, exclude the use of any other backend with 230G2 at the same time.
- The 100kHz filter bank, consisting of 256 channels of 100 kHz (splittable into two halves movable inside the 500 MHz instantaneous bandwidth, and connectable to two different receivers)
- The 500 channel AOS: (*Under repair*)
  Bandwidth 500 MHz; actual spectral resolution 1.5 MHz. Using the AOS with the 3 mm SIS receiver results in higher noise at the band edges, so the combination 3 mm SIS + AOS is not recommended.
- The autocorrelator: The software treats the autocorrelator as one unit although physically it consists of two identical machines. The following numbers are to be understood for the complete autocorrelator setup. Available resolutions are 10, 20, 40, 80, 320 and 1250 kHz. The bandwidth is between 20 MHz and $2 \times 512$ MHz, depending on resolution. The correlator can be split into 8 independent subbands, each of which can be configured individually and connected to the same or different receivers. For the larger bandwidths (i.e. more than one subband of 80 MHz) a problem of platforming may exist (i.e. baselines from the different subbands have slightly different levels).

## *Pointing / Focussing*

Pointing sessions are made every one to two weeks; at present, the fitted pointing parameters yield an absolute pointing accuracy better than $3''$ (r.m.s.). We also try to keep the receivers as closely aligned as possible (to about $2''$, however, alignment can be lost occasionally). Checking the pointing, focus, and receiver alignment is the responsibility of the observers (use a planet for alignment checks). Note that 230 G2 and 230 G1 have foci differing by 0.4 mm. Using both receivers, you should carefully monitor the focus and choose a compromise value. Not doing so may result in broadened beams (e.g. HPW 15″ and non-gaussian beams on one receiver [1]).

### *Wobbler*

- Beam-throw: from 0 to 240″ on either side of the source (avoid small amplitudes for line work).
- Standard phase duration: 2 s for spectral line observations.

References


[1] Appendix I: Error beam and side lobes of the 30 m telescope at 1.3 mm, 2 mm and 3 mm wavelength in: Molecular Spiral Structure in Messier 51, S. Garcia-Burillo, M. Guélin, J. Cernicharo 1993 Astron. Astrophys. **274**, 144-146.

[2] A Small Users' Guide to NOD2 at the 30m telescope A. Sievers (Feb. 1993)

[3] Thermal behaviour of mm-wavelength radio telescopes A. Greve, M. Dan, J. Penalver 1992 (IRAM report 233)

[4] Interferometric measurement of tropospheric phase fluctuations at 86 GHz L. Olmi, D. Downes 1992 (IRAM report 238)

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[8] Frequency switching at the 30m telescope C. Thum, A. Sievers, S. Navarro, W. Brunswig, J. Peñalver 1995, IRAM Tech. Report 228/95.

[9] Cookbook formulae for estimating observing times at the 30m telescope M. Guélin, C. Kramer, W. Wild (IRAM Newsletter January 1995)


These reports are available upon request (see also previous Newsletters). Please write to Mrs. C. Berjaud, IRAM Grenoble.

*Michel GUÉLIN, Wolfgang WILD*

# Call for Observing Proposals on the Interferometer

Observing proposals are invited for the IRAM Plateau de Bure Interferometer (PdBI), for the period Nov. 15, 1995 to May 15, 1996. The deadline for applications is September 4th, 1995. The available frequency range will be 82 GHz to 116 GHz for the 3mm band, and initially 210 to 245 GHz for the 1.3 mm band.

Details of the PdBI and the observing procedures are given in the document "An Introduction to the IRAM Plateau de Bure Interferometer" (copies can be obtained from the address below, or from Internet via the World-Wide-Web and NCSA-Mosaic software; use IRAM homepage `http://iram.fr/www/iram.html`). Proposers should read this document carefully before submitting any proposal.

Proposals should be sent to:

IRAM Scientific Secretariat
Interferometer Observing Proposal
300 Rue de la Piscine
F-38406 Saint Martin d'Hères Cedex
FRANCE

IRAM expects to schedule and complete between 20 to 30 projects in this period, with an elapsed time of at least two months between start and end of any given project. Selection will be based on scientific merit, technical feasibility, and adequacy to the instrument.

For this call for proposals, please note the following specificities:

**Proposal Category:** This will be the first winter with dual-frequency capability for Plateau de Bure. IRAM wishes to offer to its community immediate access to the new facilities, but given our lack of previous experience, we define 4 **strict** categories of proposals:

**Category 1** : Proposals that ask for 3mm data ONLY.
1.3 mm receivers can still be used to provide either phase stability information or purely qualitative information such as the mere existence of fringes. The maximum available baseline length will be about 300 m.

**Category 2** : Proposals that ask for 1.3mm data ONLY.
3mm receivers will be used for pointing and calibration purpose, but cannot provide any imaging. The maximum available baseline length will be about 200 m.

**Category 3** : Proposals that ask for dual-frequency observations.
Because of technical limitations, such proposals can only be carried out on COMPACT SOURCES (less than 15″).

**Category 4** : Exploratory proposals
Proposals whose scientific interest justifies the attempt to use the PdB array beyond its guaranteed capabilities. This category includes for example long baselines observations (A array at 3mm, B array at 1.3mm), non standard frequencies for which tuning cannot be guaranteed, and more generally all non standard observations.

IRAM will provide its usual "guarantee of completion" for all projects in the first 3 categories. On the opposite, the 4th category of proposals will NOT benefit of such a guarantee, although IRAM will of course make its best effort to complete them.

The proposal category will have to be specified *on the proposal cover sheet* (you must use the new form), and should be carefully considered by proposers.

**1.3 mm band:** All antennas are now equipped with fully operational dual frequency receivers. Since our knowledge of phase stability at 1.3 mm is based on the extrapolation of 3mm observations over the last years, no real guarantee about 1.3mm performances can be given yet. Note that even the "compact" CD array would give a resolution better than $2''$ at 1.3mm. Therefore, we have added a new configuration called D2, which in combination with the D1 configuration gives a very compact D array.

This array should be well suited for exploratory work at 1.3 mm. Though the ultimate goal of the 1.3 mm band is undoubtedly high resolution, proposers should carefully balance the pro and cons of the various configuration options for this winter.

Note that the field of view at 1.3 mm is very restricted (about $20''$).

**Dual-frequency operation:** The 3mm and 1.3mm receivers are aligned to within about $10''$. This is probably sufficient for reasonable simultaneous imaging of *compact* objects ($< 15''$), but *not* in case of extended structure. In particular, simultaneous dual-frequency imaging of nuclei of galaxies may be seriously affected. See "Proposal Category" above.

**Configurations:** The baseline extension will be completed this fall. Accordingly, the sets of available configurations have been modified. The configurations now include:

| Name | Stations | |
|---|---|---|
| D1 | W00 N05 E03 W05 | ([a]) |
| D2 | W10 W01 N09 E03 | ([b]) |
| C1 | E10 W12 N05 N13 | |
| C2 | E10 W09 N03 N15 | (*) |
| B1 | E24 E18 N11 N17 | (*) |
| B2 | E24 W12 W09 N20 | (*) |
| A1 | W27 W20 N30 E24 | (*) |
| A2 | W23 N05 N30 E18 | (*) |

([a])previously called D
([b])added to provide $3''$ at 230 GHz
(*) The details of those configurations are currently being revised to take into account the possibilities offered by the new stations W20, W23, W27 and N30.

The PdB interferometer will thus offer 4 basic arrays:

| Array | Configurations | Main purpose |
|---|---|---|
| D | D1, D2 | "Low" res. at 1.3 mm |
| CD | D1, C1, C2 | $3.5''$ res. at 3mm, $2''$ res. at 1.3 mm |
| BC | C1, C2, B1, B2 | $2''$ res. at 3 mm |
| AB | B1, B2, A1, A2 | $1''$ res. at 3 mm |

"High" resolution mosaicing at 3mm can be performed by combining BC+D1.

**Very long baselines: configuration A:**
Imaging at $1''$ resolution cannot be guaranteed for the next session. High resolution work requiring the A1 A2 configurations should preferably focus on size measurements of compact objects. Proposals asking for long baselines should be submitted in "Category 4".

**Signal to Noise:** The rms noise can be computed from

$$\sigma = \frac{J_{\rm pK} T_{\rm sys}}{\eta \sqrt{12 N_{\rm c} T B}} \qquad (1)$$

where

- $T_{\rm sys}$ is the system temperature in $T_{\rm r}^*$ scale (120 K below 110 GHz, 250 K at 115 GHz, 500 K at 230 GHz)
- $J_{\rm pK}$ is the Jansky per Kelvin conversion factor (30 at 3mm, 50 at 1.3mm)
- $\eta$ is an efficiency factor due to atmospheric phase noise (0.9 at 3 mm, 0.6 at 1.3 mm)
- $N_{\rm c}$ is the basic number of configurations (2 for D, 3 for CD, 4 for BC)
- $T$ is the integration time per configuration in seconds (3 to 8 hours, depending on source declination)
- $B$ is the channel bandwidth in Hz (500 MHz for continuum, 40 kHz to 2.5 MHz for spectral line, according to spectral correlator setup)

**Receivers:** Below 110 GHz, receivers offer best performances in LSB tuning with high rejection (20 dB): expected system temperatures are (in $T_{\rm r}^*$ scale) 100 to 150 K for the winter time. Above 110 GHz, best performances are obtained with USB tuning, low rejection (4 to 6 dB): expected system temperatures are 250 K at 115 GHz. DSB tuning is possible over the whole frequency range, but the system temperature may degrade significantly.

The 1.3 mm receivers give DSB tuning with typical $T_{rec}$ below 50 K. Expected SSB system temperature are 400 to 500 K. However a relatively narrow resonance significantly degrades the performances near

240 GHz. The guaranteed tuning range is 210-245 GHz, but it may be possible to reach lower frequencies for specific cases. Higher frequencies are unlikely to be feasible this winter because of limitations in the triplers.

**Coordinates and Velocities:** The interferometer operates in the J2000.0 system. For best positioning accuracy, source coordinates *must* be in the J2000.0 system; position errors up to 0.3″ may occur otherwise.

Please do not forget to specify LSR velocities for the sources. For pure continuum projects, the "special" velocity `NULL` (no Doppler tracking) can be used.

**Coordinates and velocities in the proposal MUST BE CORRECT: A coordinate error is a potential cause for proposal rejection.**

**Correlator:** The correlator has 6 independent units, each being tunable anywhere in the 110-610 MHz band, and providing 4 choices of bandwidth/channel configuration: 160 MHz/64, 80 MHz/128, 40 MHz/256 and 20 MHz/256. For the 40, 80 and 160 MHz bandwidth, the two central channels may be perturbed by the Gibbs phenomenon (depending on continuum strength): it is recommended to avoid centering the most important part of the lines in the middle of the band of the correlator unit.

The 6 units can be independently placed either on IF1 (3 mm receiver) or on IF2 (1.3 mm receiver).

**40 kHz resolution:** One (and *only one*) of the 6 units has been retrofitted to offer a higher frequency resolution (40 kHz instead of 80 kHz). This is obtained by operating at half clock-speed and inserting an anti-aliasing filter of effective bandwidth 6 MHz. Because the filter reduces the input power to the sampler, this unit should be placed near the maximum amplitude of the IF bandpass: band edges must be avoided.

**Sun Avoidance:** For safety reasons, the sun avoidance circle has been extended to 45 degrees. Please take this into account for your sources *and* for the calibrators.

**Mosaics:** The PdBI has mosaicing capabilities, but the pointing accuracy may be a limiting factor at the highest frequencies. Please contact S.Guilloteau in case of doubts.

**Data reduction:** Proposers should be aware of constraints for data reduction:

- In general, data will be reduced *in Grenoble*. Proposers will not come for the observations, but will have to come for the reduction.
- We keep the data reduction schedule very flexible, but wish to avoid the presence of more than 2 groups at the same time in Grenoble. Please contact us in advance.
- IRAM may consider splitting the data reduction in two phases: intermediate calibration and final mapping. Such a splitting is often absolutely necessary for the high resolution images. In such a case, the proposers must be ready to come at IRAM for fast data reduction of the "compact" configurations.
- CLIC is still evolving fast to cope with the evolution of the PdBI array. The newer versions are upward compatible with the previous releases, but the reverse is not true. Observers wanting to finish data reduction at their home institute should obtain an updated version of CLIC, which is now available. Because differences between CLIC versions may potentially result in imaging errors if new data is reduced with an old package, we insist that observers having a copy of CLIC take special care in maintaining it up-to-date.

Data reduction will be carried out on the dedicated HP workstation.

**Local contact:** Depending upon the programme complexity, IRAM may require an in-house collaborator instead of the normal local contact.

**Technical pre-screening:** All proposals will be reviewed for technical feasibility in parallel to being sent to the members of the programme committee. Please help in this task by submitting technically precise proposals. Scientific justification should be kept within 2 pages. Note that your proposal must be complete and exact: *velocities, position and frequency setup must be exactly specified.*

**Non-standard observations:**
Please contact S.Guilloteau in case of doubt about non-standard programme feasibility.

The documentation for the IRAM Plateau de Bure interferometer includes documents of general interest to potential users:

- An Introduction to the IRAM Plateau de Bure Interferometer.
- IRAM Plateau de Bure Interferometer: Calibration CookBook.
- IRAM Plateau de Bure Interferometer: Mapping CookBook.
- IRAM Plateau de Bure Interferometer: Frequency Setup.
- CLIC: Continuum and Line Interferometer Calibration.

More specialized documents are also available; they are intended to observers on the site (IRAM on-duty astronomers, operators, or observers with non-standard programmes):

- IRAM Plateau de Bure Interferometer: OBS Users Guide.
- IRAM Plateau de Bure Interferometer: Amplitude Calibration.
- IRAM Plateau de Bure Interferometer: Flux Measurements.
- IRAM Plateau de Bure Interferometer: Pointing Parameters.
- IRAM Plateau de Bure Interferometer: Trouble Shooting Guide.

All documents can be retrieved on Internet via the World-Wide-Web and NCSA-Mosaic softwares. IRAM homepage is `http://iram.fr/www/iram.html`

Finally, we would like to stress again the importance of the quality of the observing proposal. The technical preparation of observing proposals is unfortunately often insufficient. In the past, proposals were received which did not even include exact observing frequencies or even source coordinates, or worse, with coordinates with the wrong epoch !... The IRAM interferometer is a powerful, but complex and unique instrument, and proposal preparation requires special care. Information is available in the documentation, and the IRAM staff can help in case of doubts if contacted well before the deadline. Note that the proposal should not only justify the scientific interest, but also demonstrate how the Plateau de Bure interferometer will bring new information.

*Stéphane GUILLOTEAU*

# Scientific Results

## Plateau de Bure Observations of HL Tau: Outflow motions in a remnant circumstellar envelope

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*Abstract*: We present $^{13}$CO (J=1-0) observations of HL Tau with the IRAM Plateau de Bure interferometer (PdBI, 3″ beam) and the IRAM 30-m (22″ beam). On a large scale, HL Tau drives an anisotropic, mostly red-shifted bipolar outflow, and is located within a flattened remnant envelope roughly perpendicular to the jet axis, of mass $\sim 0.2$ M$_\odot$. PdBI maps reveal small-scale structures nested within these regions. A broad range of velocities is present. However, interferometric maps are severely contaminated by extended emission for velocities less than 0.8 km s$^{-1}$ from line center, which hampers a totally unambiguous interpretation. In the present analysis we concentrate on velocities sufficiently large to be mostly unaffected by this confusion problem.

We do not find convincing evidence for rotation in our data. We also identify several problems with the pure infall interpretation proposed by Hayashi et al. (1993). The required central mass would be at least $1.5 - 3.5\ M_\odot$ for $i = 55° - 80°$, which seems uncomfortably large. In addition, the detailed velocity structure and the asymmetry between blueshifted and redshifted gas are not well explained. Hence, infall alone cannot reproduce all of our observations. We derive an upper limit to the free-fall rate toward HL Tau of $\sim 6 - 9 \times 10^{-6}\ M_\odot \mathrm{yr}^{-1}$.

The problems encountered by an infall model, together with the known presence of a molecular outflow from HL Tau, lead us to propose that kinematics in the remnant envelope around HL Tau are heavily affected by entrained outflow motions. The distinctive blue/red asymmetric structure in our PdBI maps (blueshifted emission is weaker and mostly confined in the system midplane, while redshifted emission is stronger and more closely follows the jet axis) is then naturally accounted for, as the same asymmetry is observed in the large-scale bipolar outflow from HL Tau.

The action of jet bow shocks, or the steady-state entrainment of circumstellar gas, seems able to explain the transverse extent of the perturbed gas and its overall kinematics. The net molecular mass outflow rate is large ($\sim 4 - 10 \times 10^{-6}$ M$_\odot$ yr $^{-1}$), far exceeding the present

disk accretion rate, and at least comparable to the envelope infall rate. Envelope clearing by jet entrainment could then be an important process regulating the inner disk accretion rate in HL Tau, as well as the transition to the fully optically revealed T Tauri stage.

If our estimates of outflow and infall rates are correct, the modest remnant mass $\sim 0.2\ M_\odot$ inferred from our IRAM 30-m observations indicates that HL Tau has already accumulated most of its final stellar mass, and that it is in a relatively short-lived ($\leq 5 \times 10^4$ yr) phase of energetic mass ejection, leading to envelope dispersal.

## The Plateau de Bure survey of galactic $\lambda$3mm HCO$^+$ absorption toward compact extragalactic continuum sources

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*Abstract*: We have observed galactic $\lambda$3mm HCO$^+$ absorption along 30 lines of sight toward compact extragalactic mm-wave continuum sources, using the Plateau de Bure Interferometer. Such absorption is surprisingly common, occurring approximately 30% as often as $\lambda$21cm absorption in H I. In fact, the mean free path for detection of absorption with optical depth of unity is *the same* in both species. The slope of the HCO$^+$ optical depth and column density distribution functions is very similar to that of H I but the mean HCO$^+$ linewidth is much smaller, 0.95 km s$^{-1}$. A search for accompanying HCO$^+$ emission finds only an occasional weak (0.05 K) line, even when $\tau(\mathrm{HCO^+}) \gtrsim 1$, so that quite accurate column densities may be derived from observations of only the lowest line.

In comparing CO (emission) and HCO$^+$ absorption, little consistency is at first apparent. However, we can now show that the strength of CO emission increases abruptly when $N(\mathrm{HCO^+}) \approx 1-2\times\ 10^{12}\mathrm{cm}^{-2}$. This is the same phenomenon observed in *uv*-absorption studies at $N(\mathrm{H_2}) \approx 4\times\ 10^{20}\mathrm{cm}^{-2}$ and is understandable in terms of the onset of dust- and self-shielding at extinctions below 1 magnitude in diffuse clouds or the outer regions of dark clouds. A similar turn on occurs in $N(\mathrm{H_2CO})$ at the same values of $N(\mathrm{HCO^+})$.

Comparison of CO and HCO$^+$ emission and absorption can also be used to derive the physical conditions in the clouds; in general we find $n(\mathrm{H_2})T_\mathrm{K} = 0.5-1.0$, if $T_\mathrm{K}\ \geq\ 10$K. This is within but at the high end of the range for diffuse clouds studied optically and well below values appropriate to dark cloud cores. In a few cases, the presence of a relatively large electron fraction ($X(\mathrm{e}) \lesssim 1-3\ \times 10^{-4}$) seems indicated, along with temperatures of $20-30$K. Thus the excitation analysis is consistent with the existence of a CO turn on. Although it is somewhat surprising that relatively strong CO and (especially) $^{13}$CO emission is present when carbon is only partially recombined to and bound up in carbon monoxide, this is not atypical in the outer regions of dark clouds.

We have also surveyed $\lambda$18cm OH absorption in six directions using the VLA. Unlike most other species, but in keeping with traditional notions of diffuse cloud chemistry, there is a remarkably uniform relationship between the OH and HCO$^+$ column densities, even at low values. We find $X(\mathrm{HCO^+}) = 0.03-0.05X(\mathrm{OH})$ for $1\times10^{12}\ \mathrm{cm}^{-2} \lesssim N(\mathrm{OH}) \lesssim 20\times10^{12}\ \mathrm{cm}^{-2}$; this is within 40% of values quoted for TMC-1, but at 100 times lower column density. Using relevant values of $X(\mathrm{OH})$ observed in *uv* absorption spectra of diffuse clouds, $X(\mathrm{OH}) \approx 1-2\ \times\ 10^{-7}$ at $N(\mathrm{OH}) = 5\times\ 10^{13}\ \mathrm{cm}^{-2}$ and E(B-V) = 0.3 mag, it follows that $X(\mathrm{HCO^+}) \approx 3-6\ \times\ 10^{-9}$ across a very broad range of extinction.

Apparently, many diatomics and polyatomics form readily in diffuse clouds as long as there is any appreciable amount of H$_2$formation, and well before the carbon conversion from C$^+$ to CO is complete or CO emission is strong. Although the strong coupling between OH and HCO$^+$ is characteristic of conventional diffuse cloud chemistry, such chemistry in general falls far short of reproducing the observed amounts of HCO$^+$, and perhaps CO, even when OH can be explained. Although not understood at present, it is clearly the case that many molecules, including those formed on grains (*i.e.* H$_2$CO), appear with abundances characteristic of dark, cold, cloud cores even when $A_\mathrm{V} \lesssim 1$ mag.

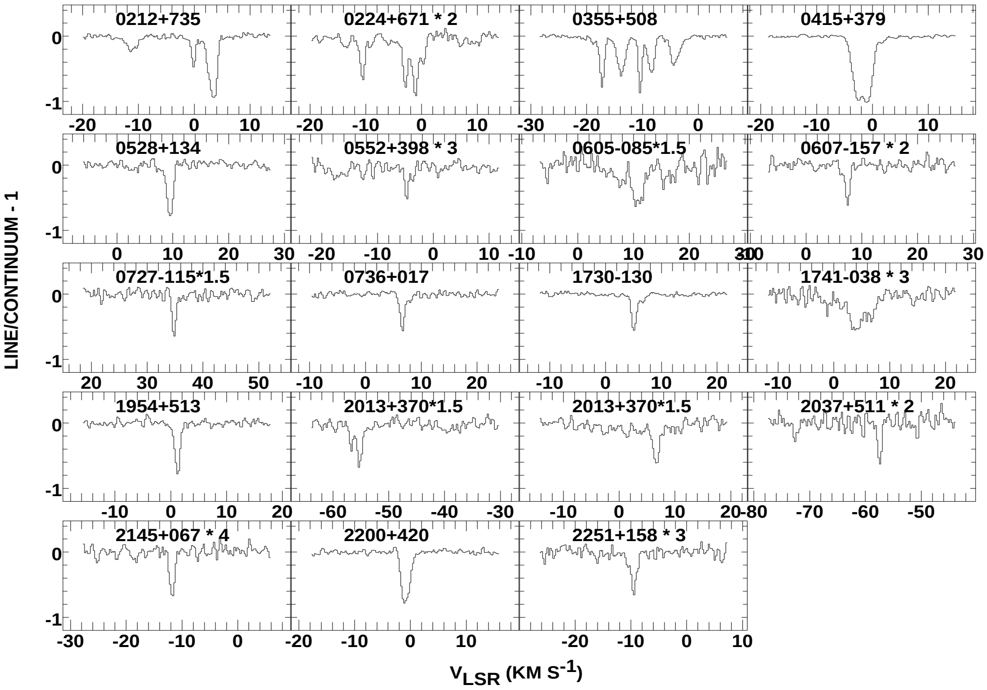


Figure 6: Digest of all detected $HCO^+$ J=1-0 absorption profiles seen at the Plateau de Bure Interferometer. The channel spacing is 78kHz and the resolution is 140 kHz (0.47 km $s^{-1}$)

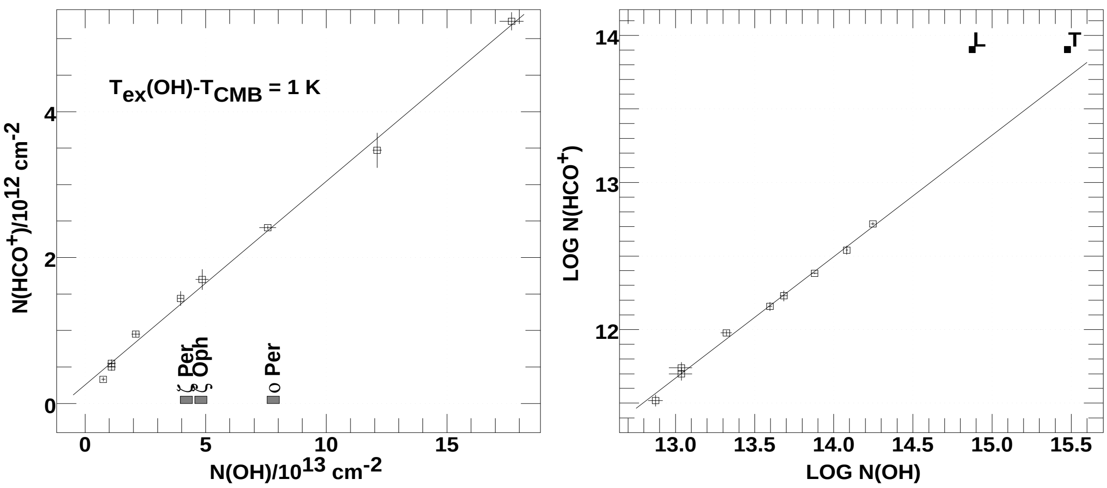


Figure 7: *Left*: Column densities of OH and $HCO^+$. The OH column densities assume 1 K excitation above the CMB; those for $HCO^+$ use $T_{\rm EX} = T_{\rm CMB}$. Column densities of OH seen in three classical diffuse clouds are shown as bars near $N({\rm OH}) = 5 \times 10^{13}$ cm$^{-2}$. *Right:* The same data plotted on a log scale, and extended to higher $N$(OH). The symbols marked L and T represent values quoted for L134N and TMC-1 by Ohishi, Kaifu, and Irvine (1992).

## Molecular distribution and kinematics in nearby galaxies: I. NGC 253

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*Abstract*: The central $80'' \times 60''$ of the edge-on starburst galaxy NGC 253 has been mapped in the $J = 2-1$ line of $^{12}$CO with the IRAM 30 m telescope (beam width: $12''$). After a Lucy deconvolution, the resolution is enhanced to $\sim 4''$. CO emission is strongly concentrated toward a region elongated along the major axis with a FWHP size of $34'' \times 11''$ (410 pc$\times$130 pc at $D$=2.5 Mpc). Toward the center of NGC 253, the $^{12}$CO $(2-1)$ line contributes between 20% and 35% to the total measured 1.3 mm "continuum" in a 50 GHz wide bandpass. Position-velocity maps reveal two condensations symmetrically placed with respect to the nucleus. Distinct velocity features suggest the presence of a compact molecular spiral, although a molecular bar or ring cannot be excluded. The dynamical mass in the inner 480 pc is $2.6\,10^9$ M$_\odot$.

Applying a "standard" $N(\mathrm{H_2})/I(\mathrm{CO})$ conversion factor of $2\,10^{20}$ cm$^{-2}$/K km s$^{-1}$, the molecular gas mass of the central condensations would be $\sim 3\,10^8$ M$_\odot$. Other tracers of molecular mass, namely optically thin C$^{18}$O rotational lines and the mm-wave dust continuum yield gas masses of $4\,10^7 \ldots 6\,10^7$ M$_\odot$. The most plausible explanation of this discrepancy is that the "standard" $H_2$ mass/CO luminosity ratio, which has been derived for Galactic disk clouds, cannot be applied to the bulge region of galaxies such as NGC 253. Possible reasons are discussed in terms of excitation conditions and the influence of the stellar gravitational potential. It is not the gas mass that makes NGC 253 an outstanding galaxy but its infrared luminosity and the "star forming efficiency" $L_{\mathrm{IR}}/M_{\mathrm{gas}}$ of 90 L$_\odot$/M$_\odot$.

## SETI at the spin flip line frequency of positronium

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*Abstract*: A directed search for extraterrestrial intelligence (SETI) has been carried out using the IRAM 30m telescope. Following a suggestion by Kardashev (1979), the search was conducted at the spin-flip line of the lightest atom, namely positronium, at 203 GHz. Most of the 17 targets are mature stars with excess infrared radiation, which might be the waste heat of a power-rich technological civilization. The rest frame of the cosmic background radiation was chosen as the velocity frame. The spectral resolution used was 9.7 kHz. From the noise level, which was determined by the limited telescope time and weather conditions, the upper limit for the power of artificial omnidirectional transmitters at the positronium line frequency is of order $10^{15}$ W. The relevance of this non-detection is discussed.

## New Preprints

The following preprints are available from IRAM:

**354.** ammonia emission from bow shocks in the L1157 outflow
M. Tafalla, R. Bachiller
1995, *Astrophys. Journal*

**355.** High density CN filaments in NGC 2023
A. Fuente, J. Martin-Pintado, R. Gaume
1995, *ApJ. Letters*

**356.** An extremely high velocity multipolar outflow around IRAS 20050+2720
R. Bachiller, A. Fuente, M. Tafalla
1995, *ApJ. Letters*

**357.** A 3D iterative deprojection technique
M. Bremer
1995, *A & A Supplement Series*

**358.** Cold dust emission from the spiral arms of M51
M. Guélin, R. Zylka, P.G. Mezger, C.G.T. Haslam, E. Kreysa
1995, *Astron. and Astrophys.*

**359.** Detection of MgCN in IRC+10216: A new metal-bearing free radical
L.M. Ziurys, A.J. Apponi, M. Guélin, J. Cernicharo
1995, *Astron. and Astrophys.*

**360.** SETI at the spin flip line frequency of positronium
R. Mauersberger, T.L. Wilson, R.T. Rood, T.M. Bania, H. Hein, A. Linhart
1995, *Astron. and Astrophys.*

**361.** Molecular distribution and kinematics in nearby galaxies: I. NGC 253
R. Mauersberger, C. Henkel, R. Wielebinski, T. Wiklind, H.-P. Reuter
1995, *Astron. and Astrophys.*

**362.** Plateau de Bure observations of HL Tau: Outflow motions in a remnant circumstellar envelope
S. Cabrit, S. Guilloteau, P. André, C. Bertout, T. Montmerle, K Schuster
1995, *Astron. and Astrophys.*

# Programmes Scheduled on the 30-m Telescope in 1994

SEP 27 - OCT 25

| Ident. | Title | Freq. (GHz) | Authors |
|---|---|---|---|
| 71.94 | The moon: brightness at mm-wavelengths | 86, 150, 230 | Greve |
| 76.94 | Zeeman effect observations with the 113GHz CN lines | 113 | Crutcher, Kazes, Troland, Lazareff |
| 16.94 | CO observations of a sample of high redshift radio galaxies | 86, 90, 102, 137, 164 | Van Ojik, van der Werf, Miley, Roettgering |
| 12.94 | A pilot study of the shock in G9.62+0.19 | 89, 138, 217 | Hofner, Churchwell, Henning |
| 79.94 | Observation of CO in P/Schwassmann-Wachmann1 and other distant comets | 115, 145, 168, 230 | Crovisier, Biver, Bockelee-Morvan, Colom, Jorda, Despois, Paubert |
| 49.94 | Mapping the cold molecular gas toward 2013+370 | 115, 230 | Wilson, Solomon, Mauersberger |
| 50.94 | Molecular gas toward Cassiopeia A | 93, 86, 110 | Wilson, Mauersberger |
| 94.94 | Gaseous counterparts of low-mass protostellar dust envelopes | 86, 96, 109, 216, 224, 260 | Andre, Despois |
| 71.94 | The moon : brightness at mm-wavelengths | 86, 150, 230 | Greve |
| 95.94 | A CO survey of metal-defient blue compact galaxies | 113, 114, 226, 228, 229 | Thuan, Sauvage, André |
| 35.94 | Observations of the gas in the most distant known galaxy | 96, 144, 216 | Mirabel, Eales, Hammer, Dunlop, Hughes, Rawlings |
| 90.94 | The extent and distribution of dense molecular gas in nearby galaxies | 88, 139, 141, 144, 145 | Gao, Solomon, Radford, Downes |
| 67.94 | Envelopes of dark clouds : TMC-1 | 109, 110, 112, 115 | Schilke, Keene, Bourlot, Roueff, Pineau des Forets, Sievers |
| $\delta$-15 | Observation of the galactic superluminal source GRS 1915+105 | | Mirabel |
| 26.94 | Molecular gas in dusty proto-planetary systems | 110, 115, 220, 230, 265 | Zuckerman, Forveille, Kastner |

OCT 25 - NOV 22

| Ident. | Title | Freq. (GHz) | Authors |
|---|---|---|---|
| 71.94 | The moon : brightness at mm-wavelengths | 86, 150, 230 | Greve |
| 61.94 | Multiline study of AFGL 5376, a 90-pc long supershock in the galactic center region | 88, 138, 220 | Uchida, Morris, Guesten, Serabyn |
| 33.94 | CO emission from intermediate z progenitors of normal galaxies | 150, 162, 225, 243, 256 | Lo, Steidel, Genzel |
| 68.94 | The high velocity system of NGC1275 | 112,224 | Reuter |
| 62.94 | Dense gas in the nuclei of $H_2O$ megamaser galaxies | 87, 114, 145, 228, 230 | Henkel, Braatz, Wilson |
| 4.94 | Search for glycine | | Combes, Rieu |
| 9.94 | A search for high mass protostars | 88, 89, 96, 147, 241 | Cesaroni, Churchwell, Felli, Walmsley |
| 53.94 | Confirmation of high redshift galaxy detection at the IRAM 30m telescope | 89, 149 | Sams, Schuster, Brandl |
| 78.94 | Molecular abundances in Comet P/Borrelly | 88, 96, 145, 165, 168, 225 | Colom, Biver, Bockelée, Crovisier, Jorda, Despois, Paubert |

| Ident. | Title | Freq. (GHz) | Authors |
|---|---|---|---|
| 178.94 | Jet entrainment in the L1157 molecular outflow : short spacing information for the CO map | 115 | Gueth, Bachiller, Dutrey, Fuente, Guilloteau, Martin-Pintado |
| 213.94 | Silicon monoxide towards ultracompact HII regions | 86, 130, 217 | Acord, Walmsley, Shepherd, Churchwell, Cesaroni |
| 78.94 | Molecular abundances in Comet P/Borrelly | 88, 96, 145, 165, 168, 225 | Colom, Biver, Bockelée, Crovisier, Fuente, Martin-Pintado, Rodriguez |
| 189.94 | A complete molecular study of the reflection nebula NGC 2068 | 110, 88, 90, 87, 113, 97, 89 | Fuente, Martin-Pintado, Rodriguez |
| 51.94 | Mapping of CO and HDO on Venus | 230, 220, 115, 225 | Encrenaz, Lellouch, Gillet, Rosenqvist, Paubert |
| 211.94 | $^{12}$CO Observations of molecular complexes in the nearby spiral M33 | 115, 230 | Viallefond, Boulanger, Cox, Guélin |
| 245.94 | The Serpens S68 FIRS1 source : From neutral molecular outflows to optical jets and HH objects | 86, 130, 217, 230, 97, 244 | Eisloeffel, Cernicharo, Guriel, Neri |
| 91.94 | CS and SiS vibrationally excited in IRC+10216 | 108, 144, 216, 145, 107 | Gonzalez-Alfonso, Cernicharo, Lucas, Guélin |
| 97.94 | Did we detect aluminium 26 in IRC+10216 ? | 209, 261, 156, 134, 201 | Guélin, Forestini, Cernicharo |

Nov 22 - Jan 3

| Ident. | Title | Freq. (GHz) | Authors |
|---|---|---|---|
| $\delta$-013 | The abundance of water at z=2.6 | | Guélin,Downes |
| 239.94 | Star formation in cometary globules | 96, 109, 115, 144, 220, 230 | Lefloch, Lazareff, Castets Cernicharo |
| 180.94 | Molecular gas content in Wolf-Rayet galaxies | 87, 88, 146, 228, 229 | Contini, Davoust, Wozniak, Considere |
| 181.94 | CO observations of powerful radio galaxies at high redshift | 87, 104, 111, 131, 232 | Evans, Sanders, Solomon, Downes, Radford |
| 247.94 | Photo-production of CN in circumstellar envelopes | 113, 226 | Bachiller, Fuente, Bujarrabal, Omont, Loup |
| 234.94 | Molecules and dust: their spatial distribution at the 10−arcsecond scale from background stars | 115, 230 | Boissé, Duvert, Thoraval |
| 235.94 | Molecules and dust: their spatial distribution at the 10−arcsecond scale from background galaxies | 115, 230 | Boissé, Duvert, Thoraval |
| 217.94 | CO, HCN and SO observations of late-type supergiants | 88, 115, 230, 219 | Blommaert, Groenewegen, Josselin, van der Veen, Omont |
| 105.94 | Search for hydrogeneous compounds in the Martian atmosphere | 115, 251, 236 | Rosenqvist, Marten, Moreau, Dutrey, Guilloteau, Guélin, Moreno |
| 206.94 | First chemical study of circumstellar disks | 88, 113, 226, 244, 260, 267 | Dutrey, Guilloteau, Guélin |
| 219.94 | Search for LiH rotational lines in collapsing primordial clouds at high redshifts | 97, 145, 217 | Maoli, de Bernardis, Melchiorri, Encrenaz, Signore |

The IRAM Newsletter is edited by Robert LUCAS at IRAM-Grenoble (e-mail address: `lucas@iram.fr`).

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|---|---|
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| e.g. `/dist/newsletter/jul95` | jul95.ps is the Postscript file for the July 1995 issue. |
| `/dist/doc` | Documentation on IRAM telescopes and software |
| `/dist/proposal` | Proposal forms and Latex files to aid proposal preparation |
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