IRAM Newsletter

Contents

Number 44 May 18th, 2000

Calendar

June 12th–16th 2000 IRAM Summer School

June 22th/23th 2000 IRAM Council

September 11th, 2000 18:00h (MET): Deadline for the submission of observing proposals for the period Nov 15, 2000 to May 15, 2001

October 9th/10th, 2000 IRAM Program Committee meeting

October 17th, 2000 Extraordinary IRAM Council meeting

Update on the situation on the Plateau de Bure

The Plateau de Bure Observatory is still operated in the same restricted manner that has been decided after the helicopter accident on December 15th, 1999, i.e. the observations are still stopped, and the activities are limited to safeguarding the installations.

To achieve this limited goal, teams of 4 people are brought up to the Plateau by helicopter for a nominal duration of 7 days each Thursday, but these periods are extended as necessary if the meteorological conditions do not meet certain, very restrictive criteria which have been agreed jointly between IRAM and the S.A.F. (Services Aériens Français). In a few cases people have also been brought by ground transport and on foot by a mountain guide, but these are exceptions, and equally restrictive weather conditions are applied as for the helicopter flights.

All technical interventions have so far been limited to diagnosing the state of the cable car installations and doing the necessary repairs, with the particular aim of avoiding any follow-on damages to the system that has been weakened by the helicopter accident. This work which is carried out under the direction of the Technical Division of CNRS-INSU, is still ongoing. In parallel, CNRS-INSU has delegated to an engineering company the preparations which are necessary to bring back a certain functionality to the system, exclusively for the transport of materials, the aim being to reduce again the number of helicopter flights.

Any change in the current level of activity on the Plateau de Bure will be preceded by an analysis of the risks associated with that activity, and such analyses are in progress. We have received the support from a team of experts belonging to the Safety Division at CERN, Geneva, which will make a safety audit for the station. They visited the Plateau de Bure during the period May 9-11, 2000.

In parallel, CNRS-INSU has prepared and issued a call for tender for an access study that will look at the technical feasibility and risks, the schedule and the costs of all means of access to the Plateau de Bure that one can realistically envisage. A similar study has been made in 1978/1979, and led to the recommendation of the cable car solution. Modern construction techniques may offer alternatives that did not exist at that time.

Within IRAM, we are looking in detail at the steps that are required to establish the actual technical state of the telescopes and the various subsystems which have not been operated since December, and to study the conditions under which observations could be restarted, at least in a limited way. As we want to keep the number of staff on the Plateau as small as possible, we will have to prioritise the activities, amongst which the necessary maintenance work on the antennas for the next winter season will inevitably be ranked very highly. Another priority task is the installation of the new correlator system which should normally take place in September this year and commissioned in the weeks to follow. Any remaining capacity will go to antenna 6, but it is clear that this antenna will not be completed this year.

All efforts mentioned above are based on the assumption that the problem of access to the Plateau de Bure can be solved and that the observatory will continue to deliver high quality scientific data for many years to come. This determination has not only been confirmed by all IRAM partners at the last Council meeting, but it has most recently been re-confirmed during a top level meeting between the CNRS and the Max-Planck-Society on May 2nd, 2000, and IRAM is grateful for this strong support.

Michael GREWING

Editor's Note

You might have noticed that this Newsletter, as the one before, has appeared about one month later than the corresponding quarterly issue of past years. This is due to the timing of important decisions (inside and outside of IRAM) concerning future developments after the tragic events of last year, and about which we want to inform our readers as soon as possible. Therefore we kept the Newsletter on hold for a while when committees were about to meet. We intend to return to the habitual publication schedule soon, hopefully for the next issue.

Michael BREMER

Post-doctoral Position

In the course of the training program in mm-wave interferometry starting at IRAM, we invite applications for a new post-doctoral position at IRAM Grenoble starting in fall 2000. The successful candidate is expected to spend two years at IRAM (with a possible extension of one year) and return to a host institution (either his/her previous or a new one).

Therefore clear preference will be given to candidates proposing to work with faculty members at host institutions jointly with IRAM astronomers, with established programs in astrophysical domains which benefit in a significant way from mm interferometry. Experience in this or other observing techniques is welcome but will not be a strong selection criterion.

The successful candidate will have to spend 50% of his/her time for service tasks and instrumentation related to the IRAM interferometer and to the future interferometer ALMA.

Applicants should have a Ph.D in astronomy or a related discipline obtained preferentially in 2000. They should submit a curriculum vitae, a publication list, and a short statement (max. 4 pages) about the science they would like to conduct during their stay at IRAM with the Plateau de Bure interferometer. This should be accompanied by a letter of strong support from a faculty member of the host institute. In addition, the names of two other scientists should be included who may be contacted by IRAM. The applications should be sent to Prof. Michael Grewing at IRAM before June 30.

Anne DUTREY

IRAM Program Committee recommendations

The IRAM program committee convened in Grenoble on April 4 – 5 to discuss the proposals submitted for the summer 2000 scheduling period. The committee was chaired by Darek Lis on April 4 (30m telescope proposals) and by Linda Tacconi on April 5 (PdB interferometer proposals).

30m telescope

100 proposals were received for the 30m telescope, requesting an unprecedented 4694 hours of telescope time, about 40% more than for preceding summer semesters.

For the 30m telescope, the highest rating “A” was given to 34 proposals, 27 proposals were rated “B”, i.e. were given backup status. The remaining proposals, although scientifically valuable in most cases, were rated “C”. The individual ratings are listed in the attached table. All A proposals will be scheduled on the 30m telescope, although some with less time than requested. We expect that less than half of the B–rated programs will actually be scheduled. The selection will take into account scientific merit, crowding in certain right ascension ranges, and general aspects of balance. Proposals rated “C” will not get telescope time.

The principal investigators of each proposal will be informed by letter which will include comments issued by the committee if there are any.

Project	PI	Institute	Rate	Subj.	Contact	E-mail
K008	C.Carilli	NRAO	A	GAL	E.Dartois	dartois@iram.fr
K00f	L.Tacconi	MPE	A	GAL	A.Dutrey	dutrey@iram.fr
K015	E.Falgarone	ENS	B	MOL	L.Loinard	loinard@iram.fr
K004	M.Sempere	CSIC	B	GAL	R.Moreno	moreno@iram.fr
K017	R.Barvainis	NSF	B	GAL	H.Wiesemeyer	wiesemey@iram.fr

A		B		C	
Proposal No.					
01–00	57–00	02–00	69–00	05–00	50–00
03–00	61–00	06–00	73–00	07–00	55–00
04–00	65–00	10–00	79–00	08–00	58–00
09–00	70–00	11–00	82–00	14–00	60–00
12–00	71–00	13–00	85–00	16–00	63–00
26–00	72–00	15–00	87–00	17–00	66–00
27–00	75–00	19–00	92–00	18–00	67–00
30–00	80–00	22–00	93–00	20–00	68–00
31–00	81–00	25–00	95–00	21–00	74–00
32–00	84–00	34–00		23–00	76–00
33–00	89–00	35–00		24–00	77–00
41–00	90–00	37–00		28–00	78–00
42–00	94–00	43–00		29–00	83–00
44–00	96–00	48–00		36–00	86–00
46–00	98–00	49–00		38–00	88–00
51–00		54–00		39–00	91–00
52–00		59–00		40–00	97–00
53–00		62–00		45–00	99–00
56–00		64–00		47–00	100–00

PdB interferometer

For the interferometer, the programs were classified A (accepted), B (backup), C (rejected) and D (deferred). Programs rated A will be scheduled in priority. Further time, if available, will go to the B programs following the same criteria as for the 30m telescope proposals. D programs have been considered as unfeasible during the summer period.

Note: As a consequence of manpower limitations and safety issues, projects for the coming season will be carried out with the Plateau de Bure interferometer on a best effort basis only. IRAM can therefore *not guarantee* to schedule all A-rated proposals. If a project is not scheduled before the end of the summer period, it will have to be resubmitted and it will be rated again together with any new programs that come in for the next season.

Project	Rate	Project	Rate	Project	Rate
K001	B	K002	C	K003	C
K004	B	K005	D	K006	C
K007	B	K008	A	K009	C
K00A	C	K00B	B	K00C	C
K00D	C	K00E	C	K00F	A
K010	C	K011	A*	K012	D
K013	A†	K014	B	K015	B*
K016	C	K017	B	K018	C
K019	B*	K01A	D	K01B	C
K01C	A*	K01D	C	K01E	A
K01F	C	K020	A*	K021	C
K022	B	K023	C	K024	A*

A: Accepted, B: Backup, C: Rejected, D: Deferred

† program rated B in one or more parts.

* program rated C in one or more parts.

Roberto NERI and Clemens THUM

Local contacts for the period May-Nov. 2000

Note that for resubmissions, the local contact has changed except when the project is already started or is a follow-up project.

Please contact your local contact as soon as possible to send him/her the setup of your project. The section "Writing the setup of your observations" (at http://iram.fr/PDBI/obs-setup.html) of the PdBI web page (http://iram.fr/PDBI/bure.html) provides the information needed to write the first iteration of your setup.

Anne DUTREY

Who needs a Fax ?

Since IRAM introduced electronic proposal submission more than a year ago, two proposal deadlines have passed. The fraction of 30m proposals submitted through the new web–based electronic facility was slightly more than 50% for the winter 99/00 deadline and 75% for the summer 2000 deadline. The acceptance of the electronic facility was even higher for the interferometer. The introduction of electronic proposal submission may therefore count as a success, particularly since all electronic proposal were

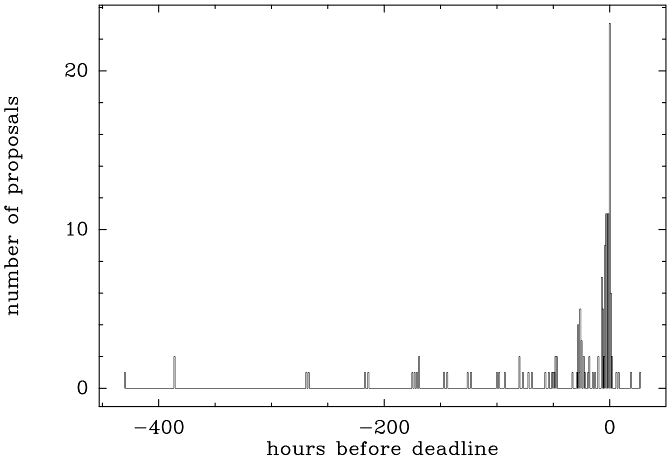

Figure 1: Number of electronic proposals which arrived per hour for the last proposal deadline.

handled correctly. No e–proposal was lost, even when proposals were arriving at a rate of one per minute shortly before the deadline (Fig. 1).

Not all is perfect though. Some proposals still do not have their figures incorporated in the `.tex` file. As the submission facility automatically creates the final postscript file from the submitted `.tex` file, the absence of figures is not noticed, unless they are explicitly incorporated. As an example, the following lines were used to incorporate Fig. 1 in this text:

```
\begin{figure}[t]
  \resizebox{\hsize}{!}
     {\rotatebox{270}
       {\includegraphics{histogram.eps}}}
  \caption[arrivals]{Number of electronic
         proposals which arrived per hour
          for the last proposal deadline. }
  \label{f:arrivals}
\end{figure}
```

The submission facility allows to view the created final postscript file. Please use this viewing option to look at your proposal as it will be passed on to the program committee.

As the vast majority of proposals now arrives to the program committee in laser printer quality, the few proposals which still arrive by fax are looked at with increasing suspicion. Please be aware that this mode of submission makes a proposal significantly less competitive: Typical grey scale plots transmitted by fax loose all definition, and are equivalent to subjecting the proposal reviewer to a Rorschach test. The outcome is predictable, and has already led to flat proposal rejections.

Reading faxed text is not necessarily simpler, or what are the proposal reviewers expected to think when they read about the source ||||7 ||? Of course, with a little reading on, cross–checking, and lots of prior knowledge, the assessor finds out rapidly that HH 7–11 is proposed to be observed. Not all assessors however enjoy these sportive aspects of their work, particularly if there are still 100 more proposals to be read.

In view of their poor legibility we therefore plan to discontinue the acceptance of faxed proposals. A questionnaire will be sent soon to the principal investigators of all proposals which were submitted by fax or normal mail for the last deadline. They will be invited to explain the reasons why electronic submission was not used, and to suggest improvements of the facility. If no strong reasons come up, fax submission will be discontinued in the near future.

Roberto NERI and Clemens THUM

News from the 30m Telescope

Summer 2000 Transport Schedule

Transports between IRAM Granada and the observatory on Pico Veleta will be arranged according to the following time table:

	Granada–30m	**30m–Granada**
Monday	08:15h	10:30h
Tuesday	08:15h	10:30h and 17:00h
Wednesday	(no transport organized)	
Thursday	10:00h	17:00h
Friday	08:15h	10:30h and 17:00h

Rainer MAUERSBERGER and Javier LOBATO

New Control System for the 30m Telescope

We are making continued progress on our plans for a New Control System (NCS) for the 30m telescope and in several areas decisions about priorities, features, and solutions will be made soon. Comments and input from all users and friends of the 30m are always very welcome and important, especially during this phase of initial decisions (see below).

In the near future many hardware components of the control system for the 30m telescope will be replaced by more modern equipment. We take this as an occasion to consider very broadly the desired features of a new system including:

- observing modes and telescope control, as well as
- data acquisition, processing, and archiving,

while maintaining the many successful features of the current system. Our goals are to:

- improve current observing modes in terms of flexibility, convenience, and data quality,

- design and implement new observing modes,
- optimize observing modes for mm-wavelength observations with a large single-dish telescope,
- allow an efficient use of telescope time,
- prepare the system for foreseeable new hardware.

We expect that a core of high priority features will form essential parts of the new system:

- observations with focal-plane arrays, including bolometers and heterodyne receiver arrays,
- continuous data taking, e.g., fast on-the-fly observations, which can be combined with other options, like frequency switching and wobbler switching,
- remote observing, service observing, and flexibility of observing and scheduling.

Linked to these core features is a need to:

- foresee very large data rates,
- optimize the standard observing modes and make them easy to use,
- automate where possible.

Details and regular updates can be found on the WWW pages for this project, which are situated at the URL http://www.iram.es/FutureControl30M. For all major topics related to the NCS we are working on reports detailing our plans and proposals. As soon as 1st complete versions of these reports are ready, they will be announced on our WWW site and in the IRAM Newsletter in order to invite a general review and comments.
For example, observing modes and user commands for the New Control System are described in:

Title: "New Control System for the 30m Telescope: Specifications: Observing Modes and User Commands"

Identifier - Master URL: http://www.iram.es//-FutureControl30M/Specifications/Spec_OM/-Spec_Observing_Modes.html

Revision: Spec_Observing_Modes, draft, V 0.5

Date: 1999-12-21

Author: Hans Ungerechts, with many contributors

Description - about this document: Requirements and specifications of observing modes and user commands for the new control system for the IRAM 30m telescope (NCS 30m). This document adopts the user's (astronomer's) view of the system, and will be revised from draft (V 0.5) to the first official version (V 1.0) in 2000 June/July, taking into account comments received. More comments are always welcome.

Hans UNGERECHTS

30M Remote Observing from MPIfR, Bonn

A remote observing station for the IRAM 30m telescope has been installed at MPIfR, Bonn. After sucessful tests in May, 2000, it is now available to users. The station can be employed for observations, but also for the real-time monitoring of activity at the 30m (i.e. during service observations). Astronomers interested in using it for their project should contact Clemens Thum (thum@iram.fr). Technical questions can be sent to Walter Brunswig (brunswig@iram.es).

The Remote Observing Station consists of a Linux computer with an ISDN interface. Communication is possible via ISDN and also via Internet (for monitoring and nighttime). Calibrated data files are transferred on-line and can be further processed locally using CLASS, ... Raw-data transfer (i.e. bolometer) is available upon request. OTF data, however, is not transferred because of the high data volume. In this case, the remote observer can do the data analysis via network on a computer at the telescope.

After the remote observing posts at IRAM Granada and IRAM Grenoble, this is the third station put into operation and the first one outside of IRAM. More installations of this kind are foreseen in Paris and Madrid.

Walter BRUNSWIG

News from the Interferometer

Observations of winter 1999/2000, and summer 2000

As already reported in the February issue of the IRAM Newsletter, all observing activity had to be stopped at the Plateau de Bure after the helicopter accident on December 15th, 1999.

The scientific activity of the observatory has not been resumed since then (the receivers are warmed up). The few proposals which were completed during winter were only those observed before December 15th. In the meantime all principal investigators with an accepted program were notified.

The interferometer is currently in the D configuration, and this will not be changed in the near future. We still hope to be able to carry out a limited number of projects. These are new proposals submitted for the coming summer period (see the recommendations of the IRAM Program Committee), as none of the projects which were submitted for winter 1999/2000 have been considered feasible during summer conditions.

We will get in touch with every principal investigator as soon as possible. We recall that since July 1st, 1999, PdBI proposals can only be carried out on a best effort basis, with no guarantee for scheduling (even for A-rated proposals).

Roberto NERI

New 133 - 190 GHz IRAM doubler

Efficiency Improvement and Fixed Tuned Mode between 130–180 GHz using IFHT Darmstadt University Diodes

Abstract

The IRAM 133–180 GHz doubler efficiency and frequency bandwidth was improved by 10% using a WV1312 GaAs diode built by C.I. Lin at the *Institut für Hochfrequenztechnik der Technischen Universität Darmstadt* (IFHTUD). In the fixed tuned mode, we obtain an efficiency between 3–10% in the frequency band 133–180 GHz.

Introduction

Recent research activities have been focused on planar Schottky diodes, but whisker contacted multipliers give more instantaneous efficiency and frequency bandwidth with lower input power. For many years, IRAM 130–180 GHz doublers (Mattiocco, Halleguen) working in the 1.5 mm SIS receiver local oscillator (LO) at Pico Veleta were built with varactor diodes from UVA [1]. The efficiencies of most doublers are between 2 and 9% in the 133–183 GHz band, using two backshorts and bias tuning.

Recently a cooperation with the IFHTHD was engaged to define the specifications of custom-built varactors for the IRAM doublers and triplers, based on the high level doping profile IFHTUD technology. The first varactor has been whisker-contacted in a doubler block built for the new 1.5 mm SIS receiver generation. Measurements of its performance are presented in the following.

Doubler

The doubler uses a waveguide input associated to a suspended substrate input filter and reduced waveguide output transformer circuits. For tuning, two backshorts and the bias voltage can be adjusted. The fixed tuned backshort mode was also studied.

Whisker contacted GaAs diodes data

The whisker length was 110 μm in both cases.

	Cjo [fF]	vb [V]	Rs [Ω]
UVA 4T3	13	11	6
IFHT WV1312	13	16	12

Results

Efficiency curves are shown in Fig. 1 over the frequency range between 130–190 GHz with 10 mW and 20 mW input power using the WV1312 diode, and with 10 mW input power using a typical doubler contacted with the 4T3 diode. The voltage bias and the two backshorts are matched at each frequency.

The efficiency for the WV1312 varactor is between 7–10% over 133–185 GHz with 20 mW input power, and 6–10% in the 133–188 GHz band with 10 mW input power. Especially above 155 GHz, the improvement relative to the 4T3 diode is significant.

Figure 2 gives the efficiency and output power for the fixed tuned case using 10 mW and 20 mW at the doubler input. The bias voltage matches the diode at each frequency, but the backshorts stay fixed. The efficiency is between 3–10% over 133–180 GHz at 20 mW input power.

Conclusions

These results are very promising for the concept of large band fixed tuned LO sources. The diodes have a good efficiency at low input power, which is essential for high efficiency multipliers at sub-millimeter wavelengths where the available input power is poor. The doubler could be associated with a multiplied and amplified YIG oscillator to make a 133–180 GHz fixed tuned LO.

Future improvements of the WV1312 diode by IFHTHD aim at a reduction of the substrate losses by applying the substrate-less technology [2], which requires a thinning of the substrate from 80 μm to 15 μm.

References

[1] Semiconductor Device Laboratory, Department of Electrical Engineering, Thornton Hall University of Virginia.

[2] C.I. Lin et al. "Substrateless Schottky Diodes for THz Applications ", 8th International Symposium on Space Terahertz Technology, Harvard University, March 1997.

François MATTIOCCO and Sylvie HALLEGUEN

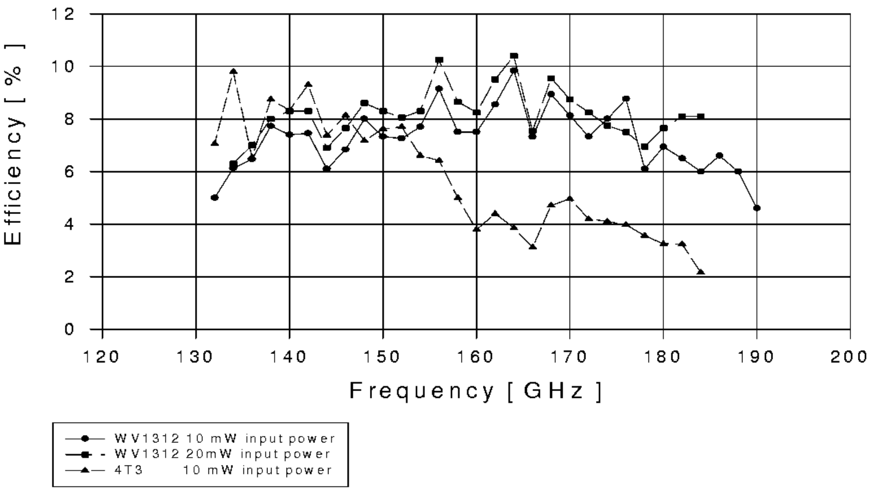

Fig. 1 : IRAM doubler efficiency with UVA or with IFH Schottky diodes

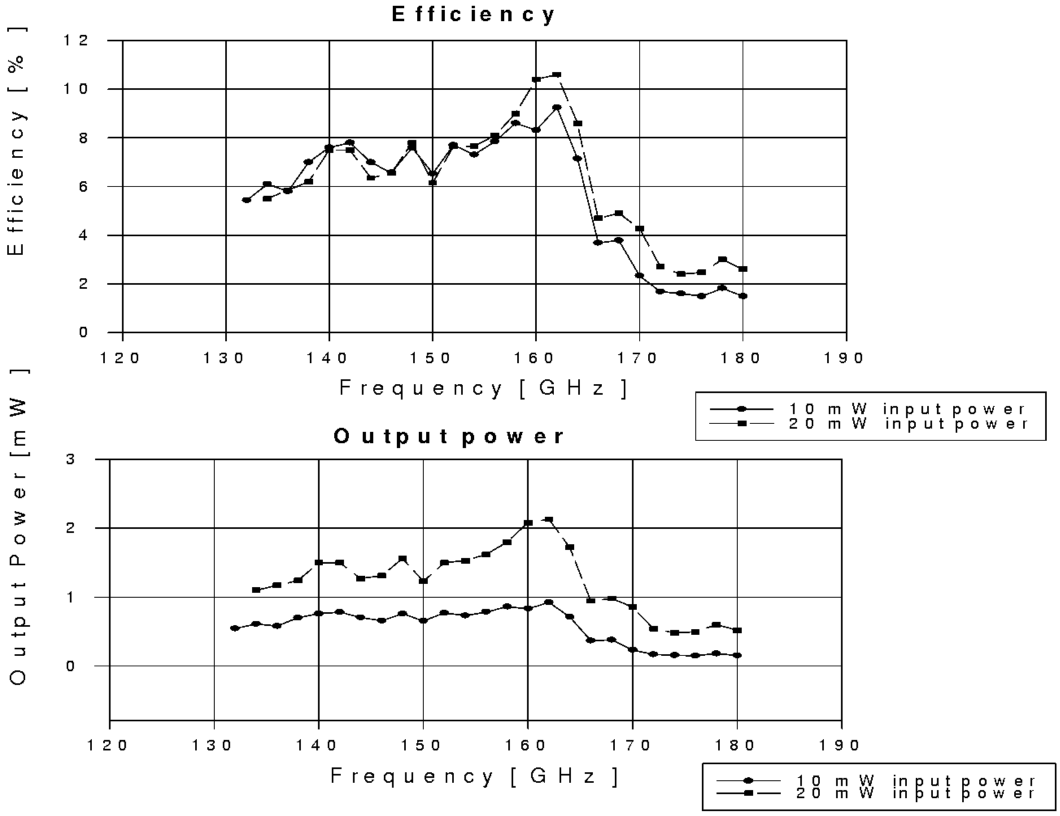

Fig.2 Fixed tuned 133 - 180 GHz doubler efficiency
and output power with 10mW and 20 mW input power

Software

NIC UPDATE:

We report an error in the `SUPPORT command` of NIC Version 1.4-07 (released on February 7, 2000).

The error, which was reported to us only recently, is sufficiently important to cause a perceptible degradation in the reconstructed images. Previous releases are not affected by this problem.

Users of the MPIfR bolometers on the 30m telescope and the SMTO who have installed NIC Version 1.4-07 should therefore replace it as soon as possible with the NIC release 1.4-08 (available since May 2, 2000), where the error has been corrected.

Some positive news: Following a number of suggestions for improvements from the users, several modifications were made on the previous release:

- the possibility to simulate complete observations with bolometer arrays, which allows a more efficient planning of the observing strategy,
- the possibility to reconstruct images under conditions of sky noise with arbitrary correlation distance,
- the refurbishment of the skydip routines which now make use of the forward efficiency of the telescope and, when available, of the instrumental response of the bolometer array, to yield a better estimate of the atmospheric opacity.

These and other minor modifications are documented in the `INFO` command.

Roberto NERI, Dominique BROGUIERE, Albrecht SIEVERS and Helmut WIESEMEYER

Scientific Results in Press

NEW MOLECULES FOUND IN COMET C/1995 O1 (HALE-BOPP) – INVESTIGATING THE LINK BETWEEN COMETARY AND INTERSTELLAR MATERIAL

D. Bockelée-Morvan ([1]), D.C. Lis([2]), J.E. Wink([3]), D. Despois([4]), J. Crovisier([1]), R. Bachiller([5]), D.J. Benford([2]), N. Biver([6]), P. Colom([1]), J.K. Davies([7]), E. Gérard([1]), B. Germain([1]), M. Houde([8]), D. Mehringer([9]), R. Moreno([3]), G. Paubert([10]), T.G. Phillips([2]) and H. Rauer([11])
([1])Observatoire de Paris, F-92195 Meudon, France ([2])California Institute of Technology, MS 320-47, Pasadena, CA 91125, USA, ([3])Institut de Radioastronomie Millimétrique, 300 rue de la Piscine, F-38406 Grenoble, France, ([4])Observatoire de Bordeaux, B.P. 89, F-33270 Floirac, France ([5])Instituto Geográfico Nacional, Observatorio Astronómico Nacional, Apartado 1143, E-28800 Alcalá de Henares, Spain, ([6])Institute for Astronomy, University of Hawaii, 2680 Woodlawn Drive, Honolulu, HI 96822, USA, ([7])Joint Astronomy Centre, 680 North A'Ohoku Place, University Park, Hilo, HI 96720-6030, USA, ([8])Caltech Submillimeter Observatory, 111 Novelo Street, Hilo, HI 96720, USA, ([9])University of Illinois, Department of Astronomy, 1002 W. Green St. Urbana, IL 61801, USA, ([10])Instituto de Radioastronomía Millimétrica, Avenida Divina Pastora 7, Núcleo Central, E-18012 Granada, Spain, ([11])DLR, Institute of Space Sensor Technology and Planetary Exploration, Rutherfordstraße, D-12484 Berlin, Germany

Abstract:
We present millimetre and submillimetre observations of comet C/1995 O1 (Hale-Bopp) undertaken near perihelion with the Caltech Submillimeter Observatory and the 30-m telescope and Plateau de Bure interferometer of the Institut de Radioastronomie Millimétrique. From a spectral molecular survey, six new cometary molecular species have been identified for the first time in a comet: SO, SO_2, HC_3N, NH_2CHO, HCOOH, and $HCOOCH_3$. Relative abundances with respect to water are 0.3% (SO), 0.2% (SO_2), 0.02% (HC_3N), 0.01–0.02% (NH_2CHO), 0.09% (HCOOH), and 0.08% ($HCOOCH_3$). Several rotational transitions of OCS and HNCO, whose first identifications were made previously in comet C/1996 B2 (Hyakutake), have also been detected, confirming that these molecular species are ubiquitous compounds of cometary atmospheres. Inferred abundances of OCS and HNCO relative to water in comet Hale-Bopp are 0.4% and 0.1%, respectively. During this observational campaign, we also observed rotational lines of HCN, HNC, CH_3CN, CO, CH_3OH, H_2CO, H_2S, and CS. In combination with results of other observations, a comprehensive view of the volatile composition of the coma of comet Hale-Bopp is obtained. A quantitative comparison shows that chemical abundances in comet Hale-Bopp parallel those inferred in interstellar ices, hot molecular cores and bipolar flows around protostars. This suggests that the processes at work in the interstellar medium, in particular grain surface chemistry, have played a major role in the formation of cometary ices. It supports models in which cometary volatiles formed in the interstellar medium and suffered little processing in the Solar Nebula.

Published in A&A 2000, **353, 1101**

DENSE GAS IN NEARBY GALAXIES.
XIII. CO SUBMILLIMETER LINE EMISSION FROM THE STARBURST GALAXY M 82

R.Q. Mao([1,2,3]), C. Henkel([1]), A. Schulz([4,5]), M. Zielinsky([6]), R. Mauersberger([7,8,9]), H. Störzer([6]), T.L. Wilson([1,7]), P. Gensheimer([7])

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Abstract:
^{12}CO J = 1–0, 2–1, 4–3, 7–6, and ^{13}CO 1–0, 2–1, and 3–2 line emission was mapped with angular resolutions of 13″ – 22″ toward the nuclear region of the archetypical starburst galaxy M 82. There are two hotspots on either side of the dynamical center, with the south-western lobe being slightly more prominent. Lobe spacings are not identical for all transitions: For the submillimeter CO lines, the spacing is ∼15″; for the millimeter lines (CO J = 2–1 and 1–0) the spacing is ∼26″, indicating the presence of a 'low' and a 'high' CO excitation component. A Large Velocity Gradient (LVG) excitation analysis of the submillimeter lines leads to inconsistencies, since area and volume filling factors are almost the same, resulting in cloud sizes along the lines-of-sight that match the entire size of the M 82 starburst region. Nevertheless, LVG column densities agree with estimates derived from the dust emission in the far infrared and at submillimeter wavelengths. 22″ beam averaged total column densities are $N(\mathrm{CO}) \sim 5\,10^{18}$ and $N(\mathrm{H_2}) \sim 10^{23}\,\mathrm{cm^{-2}}$; the total molecular mass is a few $10^8\,\mathrm{M_\odot}$. Accounting for high UV fluxes and variations in kinetic temperature and assuming that the observed emission arises from photon dominated regions (PDRs) resolves the problems related to an LVG treatment of the radiative transfer. Spatial densities are as in the LVG case ($n(\mathrm{H_2}) \sim 10^{3.7}\,\mathrm{cm^{-3}}$ and $\sim 10^3\mathrm{cm^{-3}}$ for the high and low excitation component, respectively), but ^{12}CO/^{13}CO intensity ratios $\gtrsim$10 indicate that the bulk of the CO emission arises in UV-illuminated diffuse cloud fragments of small column density ($N(\mathrm{H_2}) \sim 5\,10^{20}\,\mathrm{cm^{-2}/km\,s^{-1}}$) and sub-parsec cloud sizes with area filling factors $\gg$1. Thus CO arises from quite a different gas component than the classical high density tracers (e.g. CS, HCN) that trace star formation rates more accurately. The dominance of such a diffuse molecular interclump medium also explains observed high [C I]/CO line intensity ratios. PDR models do not allow a determination of the relative abundances of ^{12}CO to ^{13}CO. Ignoring magnetic fields, the CO emitting gas appears to be close to the density limit for tidal disruption. Neither changes in the ^{12}C/^{13}C abundance ratio nor variations of the incident far-UV flux provide good fits to the data for simulations of larger clouds. A warm diffuse ISM not only dominates the CO emission in the starburst region of M 82 but is also ubiquitous in the central region of our Galaxy, where tidal stress, cloud-cloud collisions, shocks, high gas pressure, and high stellar densities may all contribute to the formation of a highly fragmented molecular debris. ^{12}CO, ^{12}CO/^{13}CO, and [C I]/CO line intensity ratios in NGC 253 (and NGC 4945) suggest that the CO emission from the centers of these galaxies arises in a physical environment that is similar to that in M 82. Starburst galaxies at large distances ($z \sim 2.2$–4.7) show ^{12}CO line intensity ratios that are consistent with those observed in M 82. PDR models should be applicable to all these sources. ^{12}CO/^{13}CO line intensity ratios $\gg$10, sometimes observed in nearby ultraluminous mergers, require the presence of a particularly diffuse, extended molecular medium. Here [C I]/CO abundance ratios should be as large or even larger than in M 82 and NGC 253.

Acknowledgements: Based on observations with the Heinrich-Hertz-Telescope (HHT) and the IRAM 30-m telescope. The HHT is operated by the Submillimeter Telescope Observatory on behalf of Steward Observatory and the Max-Planck-Institut für Radioastronomie.

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The structure of the collapsing envelope around the low-mass protostar IRAS 16293-2422

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Abstract:
Using H_2O, OI and SiO data, we derive the structure of the collapsing envelope around the low-mass protostar IRAS 16293-2422 down to $r \sim 30$ AU. With an accurate model which computes self-consistently the chemical composition, thermal balance and line emission from a collapsing envelope (Ceccarelli, Hollenbach & Tielens 1996), we find that IRAS 16293-2422 is a 0.8 $\mathrm{M_\odot}$ protostar accreting from the surrounding envelope at a rate of 3.5×10^{-5} $\mathrm{M_\odot\ yr^{-1}}$, in good agreement with previous studies. The model predicts that the water abundance in

the outer (r $\geq$ 150 AU) part of the envelope is 5×10^{-7} with respect to H nuclei, while it is a few times larger at smaller radii (r $\leq$ 150 AU). This enhancement results from the evaporation of icy grain mantles when the temperature exceeds $\sim$ 100 K. The same model can reproduce the observations of the SiO J=2–3 to J=8–7 lines provided the abundance of SiO is 1.5×10^{-8} in the inner region, while it is only 4×10^{-12} in the rest of the envelope. The SiO abundance enhancement in the inner regions is likely due to the evaporation of the grain mantles also responsible for the abundance enhancement of H_2O. The cooling and heating mechanisms of the gas throughout the envelope as derived from the model are discussed, and used to derive the gas temperature profile.

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The hot core of the solar-type protostar IRAS 16293−2422: H_2CO emission

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Abstract:
We model the H_2CO and $H_2{}^{13}CO$ line emission observed towards the solar-type protostar IRAS 16293-2422. Based upon previous analysis of the physical structure of the envelope surrounding IRAS 16293-2422, we develop a model in which the H_2CO lines are emitted by two components: a cold H_2CO-poor outer envelope and a warm H_2CO-rich core. We find that the model reproduces successfully all the available H_2CO and $H_2{}^{13}CO$ data for a H_2CO abundance equal to $(1.1 \pm 0.3) \times 10^{-9}$ in the outer and $(1.1 \pm 0.4) \times 10^{-7}$ in the inner regions of the envelope respectively. We interpret this increase of the H_2CO abundance as due to the evaporation of the grain mantles when the dust temperature exceeds 100 K at about 150 AU from the center, forming a hot core like region. Assuming that all mantle constituents evaporate and are detected in the gas phase, we derive that the H_2CO-ice abundance is about 3% of the H_2O-ice abundance. This is the first measurement of the H_2CO abundance in grain mantles around a low-mass protostar.

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Molecular Line Observations of Proto-planetary Nebulae

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Abstract:
We present our recent results on mm-wave CO observations of proto-planetary nebulae. These include high-resolution interferometric maps of various CO lines in three well known bipolar PPNe: M 1-92, M 2-56 and OH 231.8+4.2. The global properties of the high velocity molecular emission in post-AGB sources have been also studied, by means of high-sensitivity single dish observations of the J= 1-0 and J=2-1 lines of ^{12}CO and ^{13}CO. We discuss the implications of these results to constrain the origin of the post-AGB molecular high-velocity winds and the shaping of bipolar PPNe and PNe. In addition, we also present the results of an interferometric map of the molecular envelope around the luminous high-latitude star 89 Her, a low mass post-AGB source which is also a close binary system.

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Molecular Emission from the Shocked Bipolar Outflow in OH 231.8+4.2

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Abstract:
We present high-resolution observations of several molecular lines in OH 231.8+4.2 taken with the IRAM interferometer. All molecules are distributed in a narrow region along the symmetry axis, and flow outwards following a velocity gradient similar to that found in CO. The HCO+ emission is found to be very clumpy and strongly enhanced in the shock-accelerated lobes, indicating that the formation of this molecule is probably dominated by shock induced reactions. SO is present in the axial outflow as well as in an expanding equatorial disk. The SiO maser emission seems to arise from the innermost parts of such a disk. We also report the first detection of NS in circumstellar envelopes.

Appeared in Asymmetrical Planetary Nebulae II:ASP Conference Series, Vol. 199

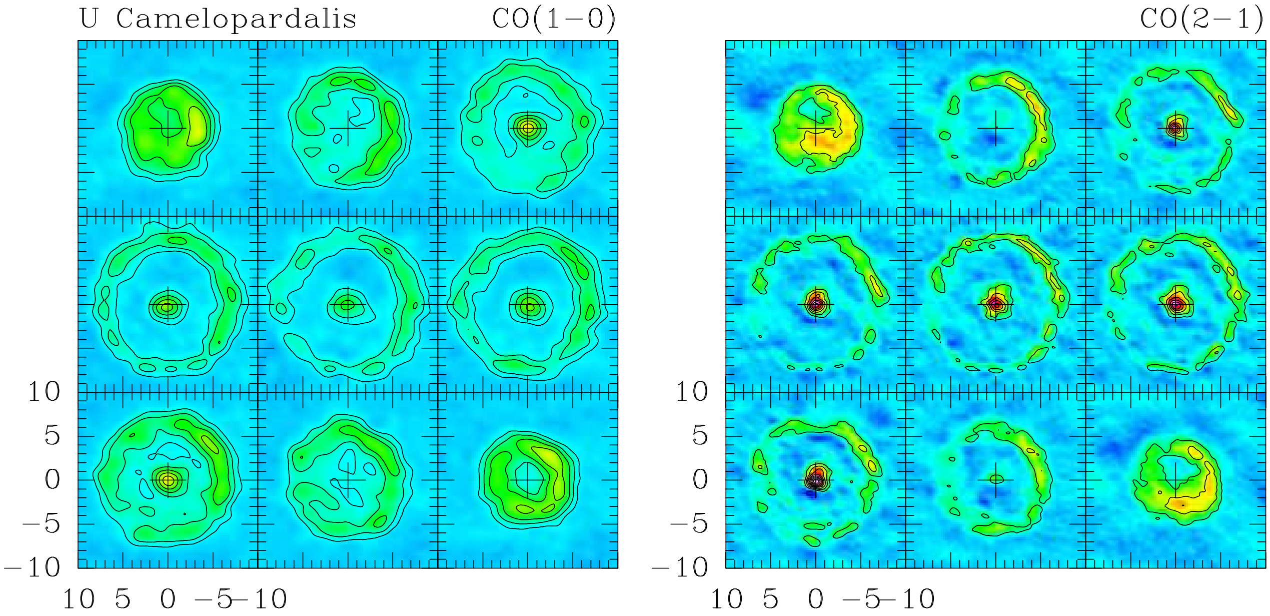

Figure 2: Lindqvist et al.: CO(1-0) and CO(2-1) maps of the shell around U Cam

The young detached CO shell around U Camelopardalis

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Abstract:
We report IRAM Plateau de Bure interferometer observations of the carbon star U Cam in the CO(1-0) and CO(2-1) lines. The remarkable images (Fig. 2) show that U Cam is surrounded by a geometrically thin, $\sim 10^{16}$ cm, shell of gas at a distance of $\sim 6 \times 10^{16}$ cm from the star, that expands with a velocity of $\sim 23\,\mathrm{km\,s^{-1}}$. The estimated mass of the shell is low, $\sim 10^{-3}\,\mathrm{M_{\odot}}$. In addition, we detect emission that peaks at the stellar position. From this we estimate a present mass loss rate and gas expansion velocity of $\sim 2.5 \times 10^{-7}\,\mathrm{M_{\odot}/yr}$ and $12\,\mathrm{km\,s^{-1}}$, respectively. One possible explanation to the structure of the circumstellar medium is that the shell was produced during a very short period, ~ 150 yr, of high mass loss rate, $\sim 10^{-5}\,\mathrm{M_{\odot}/yr}$, about 800 yr ago. U Cam may fit into the scenario where a helium-shell flash modulates the mass loss rate on short times scales.

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The enormous abundance of D_2CO in IRAS16293–2422

L. Loinard(1), A. Castets(2), C. Ceccarelli(3), A.G.G.M. Tielens(4), A. Faure(3), E. Caux(5) and G. Duvert(3)
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Abstract:
Ceccarelli et al. (1998) recently reported the detection of D_2CO in the low–luminosity protostar IRAS 16293–2422. Using the data available at the time, they found that the abundance of D_2CO might be as high as 1/10th that of its hydrogenated counterpart H_2CO. Here we describe and analyse new multi–transition observations of D_2CO, HDCO, H_2CO, and $H_2{}^{13}CO$ towards IRAS 16293–2422. Correcting for the opacity of the H_2CO lines, we find that the abundance of D_2CO is $\sim 5\%$ that of H_2CO. In addition, we find a component in absorption – also associated to IRAS 16293–2422, but at larger radius – where the abundance of D_2CO compared to H_2CO could be even higher. Though slightly lower than initially claimed, the abundance of D_2CO in IRAS 16293–2422 is extremely high, more than one order of magnitude higher than in Orion KL, the only other source where D_2CO has ever been detected. Because the gas temperature (T = 20–50 K) is too high, deuteration in the gas–phase is very insufficient to explain such high abundances. We conclude that

D_2CO is most likely *not* currently formed in the gas phase, but is evaporated from the dust grains, where it has been accumulating during the cold, dense pre–collapse period.

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Starburst in the Ultraluminous Galaxy Arp 220 - Constraints from Observations of Radio Recombination Lines and Continuum

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Abstract:
We present observations of recombination lines (RRL) from Arp 220 near 8.1 GHz (H92α) and 1.4 GHz (H167α and H165α) made using the Very Large Array and near 84 GHz (H42α), 96 GHz (H40α) and 207 GHz (H31α) made using the IRAM 30 m telescope (Fig. 3). RRLs were detected at all the frequencies except at 1.4 GHz where a sensitive upper limit was obtained. We also present continuum flux measurements at these frequencies as well as at 327 MHz made with the VLA. The continuum spectrum which has a spectral index $\alpha \sim -0.6$ ($S_\nu \propto \nu^{-\alpha}$) between 5 and 10 GHz, shows a break near 1.5 GHz, a complete turnover below 500 MHz and a higher spectral index above 50 GHz.

We show that a model with three components of ionized gas with different densities and area covering factors can consistently explain both RRL and continuum data. The total mass of the ionized gas in the three components is 3.2×10^7 $M_\odot$ requiring 4.2×10^5 O5 stars with a total Lyman continuum (Lyc) production rate $N_{Lyc} \sim 1.3 \times 10^{55}$ photons s^{-1}. The ratio of the expected Brα and Brγ fluxes implies a dust extinction corresponding to $A_v \sim 45$ magnitudes. The derived Lyc photon production rate implies a continuous star formation rate (SFR) averaged over the life time of OB stars of ~ 240 $M_\odot$ yr^{-1}. The Lyc photon production rate of $\sim 3\%$ associated with the high density HII regions implies similar SFR at recent epochs ($t < 10^5$yrs). An alternative model of high density gas, which cannot be excluded on the basis of the available data, predicts ten times higher SFR at recent epochs. If confirmed, this result implies that star formation in Arp 220 consists of multiple starbursts of very high SFR (few $\times 10^3$ $M_\odot$ yr^{-1}) and short durations ($\sim 10^5$ yrs). The similarity of IR-excess, $L_{IR}/L_{L_\alpha} \sim 24$, in Arp 220 to the values observed in starburst galaxies shows that most of the high luminosity of Arp 220 is due to the on-going starburst, rather than due to any hidden AGN. A comparison of the IR-excesses in Arp 220, the Galaxy and M33 indicates that the starburst in Arp 220 has an IMF which is similar to that in normal galaxies and has a duration longer than 10^7 yrs. If there was no infall of gas during this period, then the star formation efficiency (SFE) in Arp 220 is $\sim 50\%$. The high SFR and SFE in Arp 220 is consistent with their known dependences on mass and density of gas in star forming regions of normal galaxies.

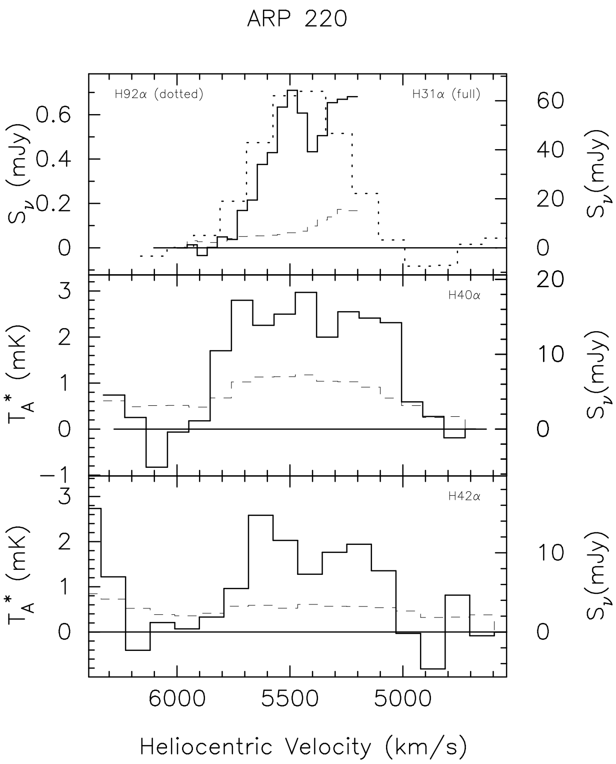

Figure 3: Recombination lines from Arp 220 in the 3mm (H40α and H42α) and the 1.2 mm (H31α) bands observed using the IRAM-30m. Solid lines are the observed line profiles corrected for a linear baseline. The dashed lines represent statistical rms noise level in each channel including the uncertainty in the baseline level. The dotted line in the top frame is the integrated H92α line profile from the VLA observations

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2000, *Astronomy and Astrophysics*

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