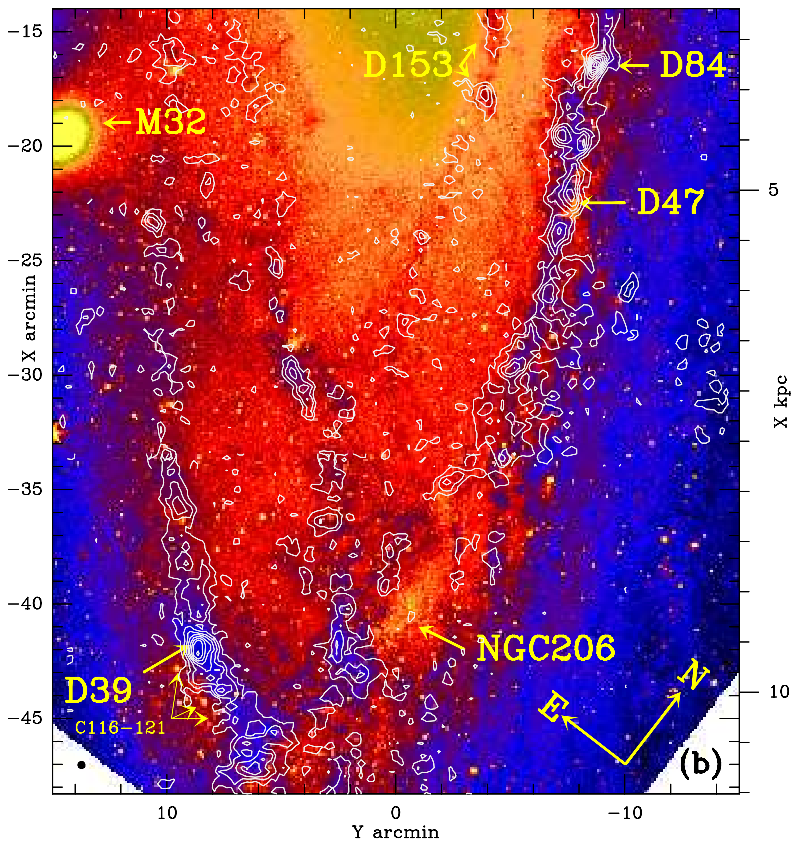
# IRAM Newsletter

## Contents



Number 37 October 4th, 1998

## Cover Picture




**On-The-Fly CO map of M 31** The velocity-integrated CO intensity in the SW half of M 31, superimposed on a red image from the Palomar Digital Sky Survey (from Neininger, Guélin, Ungerechts, Lucas and Wielebinski 1998, *Nature*, in press). $X$ and $Y$ are along the major and minor axes, respectively. Observations were made 'on-the-fly' with the IRAM 30-m telescope using a basket-weaving procedure: the telescope was moved back and forth at a speed of $4''\mathrm{s}^{-1}$ in the $Y$ direction with steps in $X$ of $8''$, then back and forth in the $X$ direction, with steps of $8''$ in $Y$. The data, dumped every 1s, were reduced using a de-striping algorithm. Only one set of orthogonal coverages were needed to reach an r.m.s. noise of $\Delta T_A^* = 0.5$ K kms$^{-1}$ in a 60 kms$^{-1}$-wide band. The peak intensity in the map is 20 K kms$^{-1}$. More details about the M 31 study can be found on p.3 below. Implementation of the spectral line OTF observing mode on the 30-m telescope was made by the IRAM Granada group, in particular H. Ungerechts, A. Sievers, W. Brunswig, K. Kramer, G. Paubert and W. Wild, with support from J. Schraml (MPIfR). The data reduction software was adapted by R. Lucas and H. Sievers and, for the destriping algorithm, by P. Hoernes.

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## Calendar

**January 5th, 1999** Next IRAM Newsletter

**March 8th, 1999:** Deadline for the submission of observing proposals for the period May. 15, 1999 to Nov. 15, 1999

**April 8-9th, 1999** Next Program Committee meeting

# Latest news

30-m Receiver Cabin Refurbishment: First light

The refurbishment of the 30-m telescope receiver cabin described below in Sec. 2 has so far progressed according to schedule. The cabin has been emptied completely of the previous equipment. The new support frames and receivers have been installed during the first week of October. Figure 1 shows the very first pointing scan with the four new receivers in parallel, obtained the night after the installation was completed. The alignment is "as is" following installation and laser alignment. It seems that no further adjustment will be necessary for the moment. The diplexers were not yet calibrated, and were at random positions. The effective value(s) of the calibration load had not yet been determined (different intensities for receivers at the same frequency).

Much work remains to be done to fully characterize the system. A more complete report will appear in the next issue of the Newsletter.

*The construction teams*

# News from the 30-m Telescope

### Receiver cabin refurbishment

On 1 September 1998 the 30m telescope was stopped for astronomical observations for nearly two months to carry out the largest technical work since the telescope was built. The receiver cabin is in the process of being completely refurbished with new receivers, IF and LO systems, optics, calibration system, mechanical supports, electrical installation, new floor etc. This large and coordinated effort involves many groups both from Granada and Grenoble (such as the receiver, workshop, computer, logistic and astronomy groups).

The receiver cabin is now prepared to accomodate a total of 8 receivers (4 dual channel dewars) covering the 3mm, 2mm and 1.3mm (low and high) atmospheric windows. The cabin is also ready for the future installation of the 9 pixel (later 18 pixel) 1.3mm imaging receiver (under construction in Grenoble).

Two dual channel dewars with two 3mm and two 1.3mm receivers are being installed (see Sec. 1 above) and the "old" 2mm receiver will added to the new system. They should be available during the coming winter (1998/99). In a second step (probably in summer 1999), the receiver cabin will be equipped with two more dual channel receivers covering the 2mm and 1.3mm (high) windows. In the final setup, 4 receivers out of 8 can be used simultaneously.

In parallel to the work in the receiver cabin, a number of other activities are carried out during September/October making use of the night time and access to the telescope (which is usually not easy due to the high demand for observing time). During September, the 40 GHz holography receiver was installed in the prime focus and used to investigate the main reflector surface quality and thermal deformations. A new wobbler control system under VME could be thoroughly tested and improved. Other maintenance and repair activities (such as repairing a whole in the antenna cladding caused by a lightning) are also performed during this period.

### Remote observing from IRAM Grenoble

Remote observing at Pico Veleta is now possible from IRAM Grenoble for technically easy, not too long projects and experienced 30m observers. Further tests during the summer were very promising. Remote observing from Grenoble may be useful for long integrations, detection experiments and other projects that do not require a lot of interaction. It is also an interesting alternative for projects that would otherwise be done in "service observing". Other than in service observing, the remote observer can change his or her observing strategy during the run.

Some of the limitations at the moment are the use of written communication with the telescope operator (xhchat split screen, there is no voice link yet), and the lack of some alarm signals at the remote location (e.g. phase lock alarm). Experience shows that the connection between Grenoble and Pico Veleta via a digitial ISDN telephone line is stable once it is established. Problems have sometimes occured during the startup phase.

Everyone interested in using remote observing from Grenoble should contact well in advance W. Wild (wild@iram.es) or C. Thum (thum@iram.fr) in order to discuss the suitability of the project and arrange for an introduction and trial run.

*Wolfgang Wild*

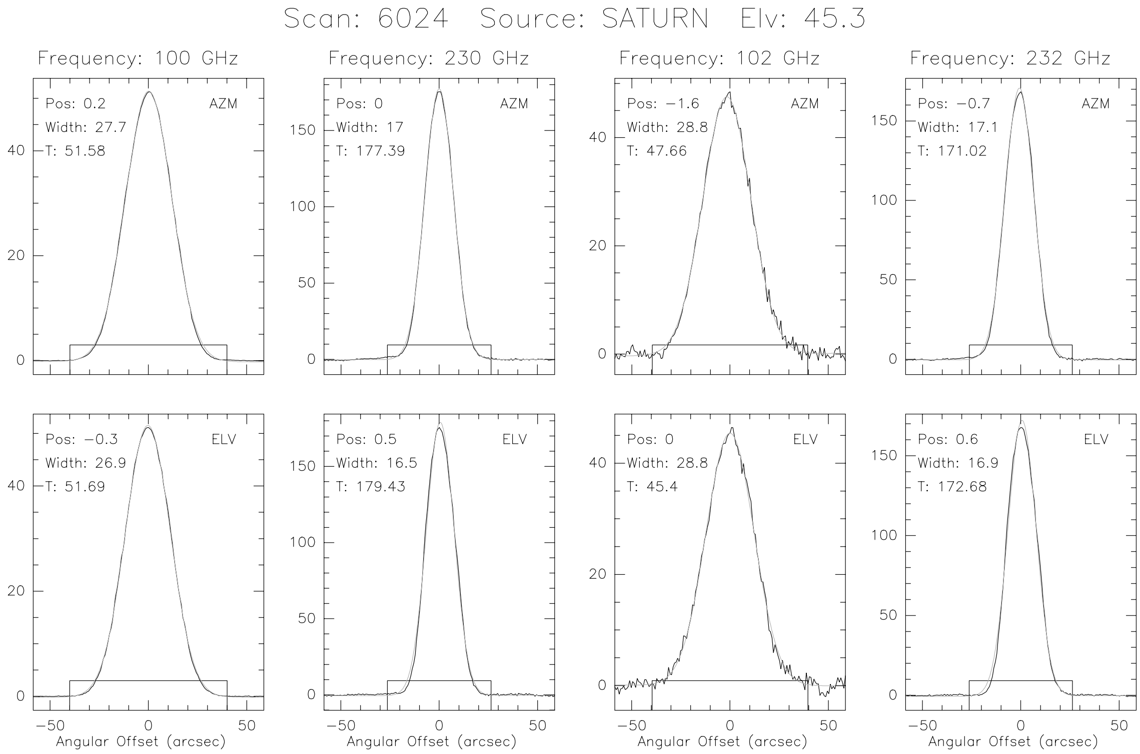


Figure 1: First co-alignment check after physical installation of the new receivers

# Future control system for the 30-m Telescope

We have started to plan a new control system for the 30-m telescope. I (Hans Ungerechts, email: ungerechts@iram.es) have been asked to coordinate IRAM's work on this project.

Changes will include a move to new hardware as well as new software and new features at the user level. While maintaining the many successful features of the current system, we will use this opportunity to rethink the system very broadly in order to serve the needs of the observers better, to make the operation and use of the telescope easier, and to achieve more flexibility in the data acquisition, processing, and archiving.

All users of the 30-m are strongly encouraged to let us know their suggestions for improvements of the observing system and especially ideas for new observing modes.

There will be a new WWW page with information and regular updates about this project at our site **http://www.iram.es/** (and **http://iram.fr/**).

*Hans Ungerechts*

# New configurations for Bure

The Plateau de Bure Interferometer (PdBI) is currently undergoing two major upgrades. A 6th antenna is being built and is scheduled to be fully operationnal by the end of 1999, while the Northern track will be extended from 232 meters (station N29) to 416 meters (N46) within the same timescale. This will provide higher sensitivity, higher observing efficiency, higher angular resolution, and more circular beams. To take full advantage of those improvements, new configurations of the instrument are needed, and are currently under investigations. This document provides informations about the improvements that will result from the upgrades and describes likely new configurations of the interferometer. In the last part, we compare the relative merits of extending the Northern track even further (up to N52) or of doubling the length of the Eastern track (from E24 to E48).

Currently, the antennas can be arranged in 6 primary configurations (D, C1, C2, B1, B2 and A1 – http: iram.fr/PDBI/bure/bure.html) that can be combined together to yield four angular resolutions ranging from $6''$ (at 100 GHz for configuration D) to $1.3''$ (at 100 GHz for configuration A). With the upgrades, a similar set of four angular resolutions will be kept, but will probably require less primary configurations. Furthermore, the 6th antenna will provide a better sensitivity to the most compact configuration, making this configuration even more adequate for detection experiments.

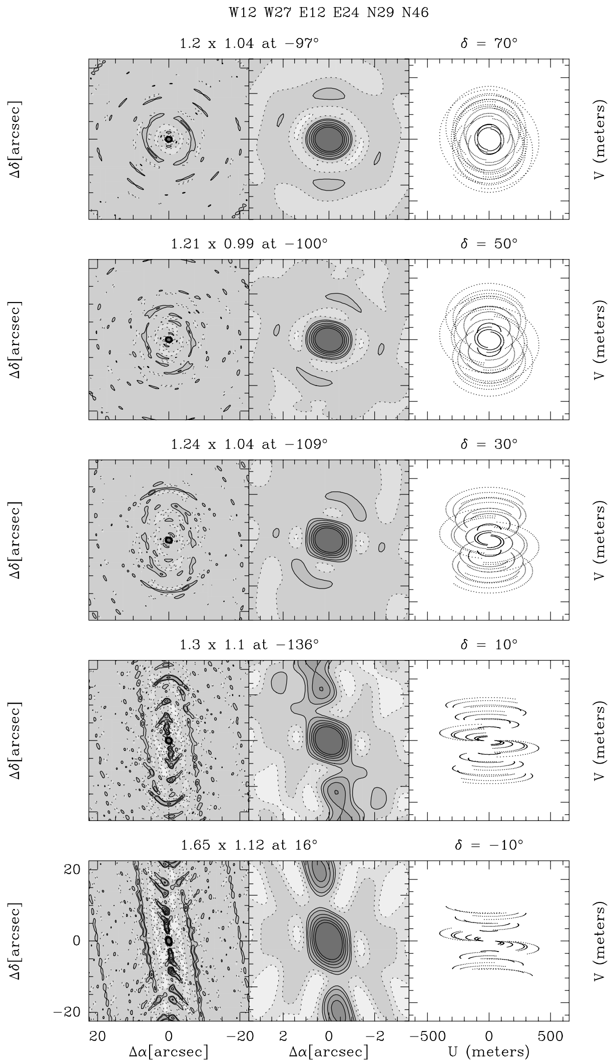


Figure 2: Long baseline configuration with North track extension and 6 antennas. Contours are -20, -10, -5, 5, 10 to 50 % by 10%.

**Configuration D:** With 6 antennas, the most compact configuration will become "W05 W08 E03 N02 N07 N11", which provides $5''$ resolution at 100 GHz instead of $6''$ for the previous D configuration. This slightly extended configuration was chosen because for more compact situations, heavy shadowing occurs. The main improvement will be a 22% increase in sensitivity.

**Configuration C:** For the next most compact configuration (C) we suggest "W09 W12 E03 E10 N03 N13", which provides about $3.5''$ resolution at 100 GHz, or $1.5''$ at 230 GHz. This configuration contains a few short baselines, and provides a fairly complete coverage of the UV plane. It is therefore likely that – thanks to the 6th antenna – the C configuration will require only one primary configuration, instead of two previously.

In selecting this configuration however, the balance between the number of short baselines with respect to longer ones, and the possible complementarity between the C and D configurations argue in opposite directions. The community is invited to present arguments on the relative interests of "fast" imaging (single configuration) versus low sidelobes (D + a more extended C′ configuration).

**Configuration B:** The B type configurations provide a resolution of about $2''$ at 100 GHz and is intermediate between the compact (D and C) configurations discussed above and the extended (A) configuration below. We are searching for a single configuration which would provide proper UV coverage when combined with the C configuration, and which could still be combined with A type configurations for high resolution mapping of moderately extended objects.

**Configuration A:** This most extended configuration will make use both of the increase in the number of antennas and of the extension of the Northern track. While the 6th antenna will obviously improve the sensitivity, the extension of the Northern track will have two effects.

First, it will improve the "absolute" angular resolution since the longest baseline (E24–N46) will now be 460 meters long instead of 400 meters previously. Second, the extension towards the North will greatly improve the shape of the beam, especially for low declination sources.

There are two possible classes of A configurations, both yielding roughly equivalent angular resolutions ($1.1''$ at 100 GHz; $0.50''$ at 230 GHz). The first type corresponds to the antennas put on the two farthest stations of each track (in our case: "W23 W27 E18 E24 N29 N46"). This will provide the highest number of long baselines, a few short ones, but no intermediate ones. Such a configuration would then have to be combined with a B type configuration to provide proper mapping, but when this is done, a large range of spacings will be recovered and high resolution imaging of even fairly extended objects could be done. Another possibility is to put one antenna at the end of each track and one roughly at the middle. One example is W12 W27 E12 E24 N29 N46 (Fig.**??**). This configuration **alone** is well suited for mapping or size measurements of very compact objects. In addition, because it contains both long and intermediate baselines, it could still be used during marginal weather conditions – combined with some tapering – to yield resolutions equivalent to those of a B-type configuration. This could subtantially improve the observing efficiency, particularly during the winter season. However, such a configuration is certainly not ideal for the high resolution mapping of moderately extended objects, and even when combined with a B type configuration may be less adequate than the other class discussed above. The possibility of having two A configurations (one of each type) is worth considering. Note furthermore that switching between the two would require the moving of only three antennas, an important aspect since shuffling the snow along the tracks is a time consuming task necessary prior to the moving of the antennas.

An additionnal question is that of a future extension of the array. During the preparation of the Northern track extension, it appeared technically possible to go up to N51

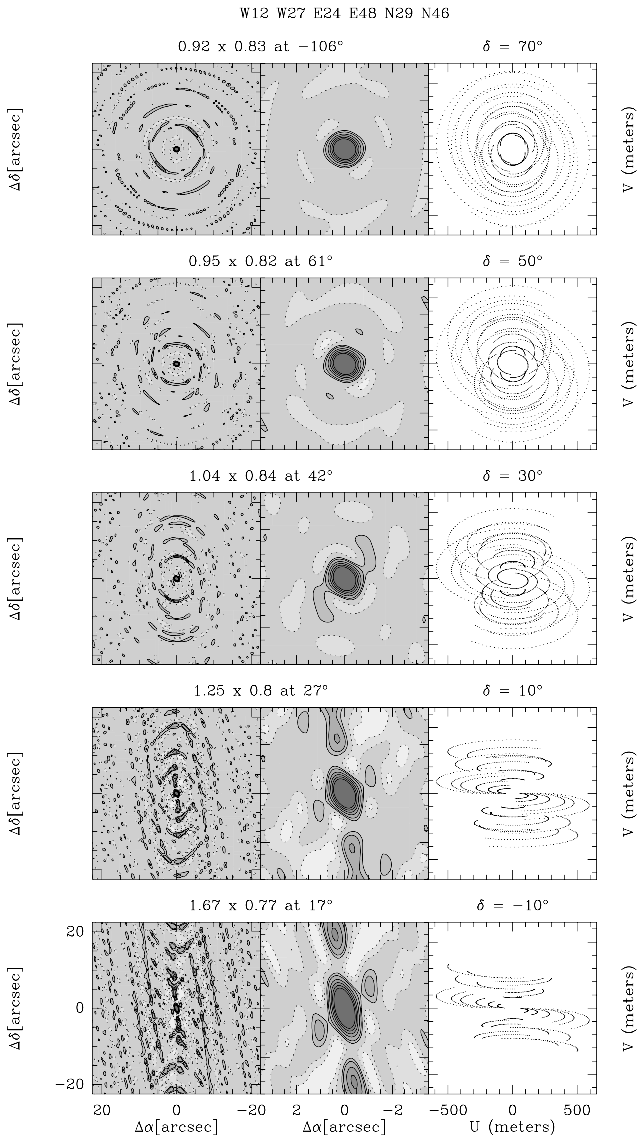


Figure 3: Long baseline configuration with North and East track extension

instead of N46, thereby gaining an aditional 10% on the longest baselines. However, the cost is high (most likely above 2 MFF). For a very similar cost (2.5 MFF), owing to the topography of the Plateau de Bure, we could probably extend the array to the East, up to E48 (instead of E24 currently). The longest baseline would then be 590 meters. As an example, we show the result of configuration W12 W27 E24 E48 N29 N46 (Fig.3), which yields a resolution of $0.95''$ at 100 GHz (and $0.4''$ at 230 GHz).

**Users of the IRAM PdBI are invited to comment on the choice of these future extensions and configurations (contact L.Loinard – loinard@iram.fr).**

*L.Loinard, S.Guilloteau*

# News from the Interferometer

### Observations during the last semester

Despite relatively poor late summer conditions at Plateau de Bure, we are well on the way to complete all the A-rated projects before the end of the year. Moreover, a substantial number of B-rated projects requesting essentially observations in the 80 to 115 GHz frequency window, was also carried out. All the observations were carried out with the array in 4-antenna configurations. The backlog from the previous two observing periods amounts now to less than 200 hours and will, if weather allows, be widely worked off in the month to come.

Please note that information on scheduled configurations for ongoing projects and on the current observational backlog can be retrieved from **http://iram.fr/PDBI/ongoing.html**. This page is updated every day.

### Maintenance

The annual antenna maintenance is now almost complete. We have put a lot of work to replace a large number of carbon fiber panels on antennas 1, 2 and 4. All these panels (87 in total) were showing through the years clear signs of an irremediable and incessant degradation of the Hostaflon surface, a consequence of the longstanding pin-hole problem which affects part of the surface of our first generation antennas. The replacement was made with a selected but well-preserved set of panels gathered in from antenna 3. This antenna was already completely re-equipped with aluminium panels during the 1997 antenna maintenance period.

Holography and surface adjustment of these antennas are already underway and will, if weather allows, be completed in time for the begin of the winter session.

*R. Neri*

# IRAM Program Committee recommendations

The IRAM program committee, chaired by Thierry Montmerle, convened in Grenoble on October 5 - 6 to discuss the proposals submitted for the winter 1998/99 scheduling period. A heavy load of 138 proposals requesting a total of 6421 hours were received for the 30-m telescope and 78 proposals were received for the interferometer. Considering technical periods, VLBI and, in the case of the interferometer, weather contingencies, both instruments are oversubscribed by more than a factor 3.

For the 30m telescope, the committee gave the highest rating "A" to 43 proposals. The bolometer proposals fared particularly well receiving 48 percent of the A-time. 25 proposals received backup status. Like last summer, the committee accepted several proposals requesting more than 100 hours. The individual ratings are listed in the attached table (the proposal numbers were communicated to the PIs shortly after submission).

**30-m Telescope program ratings**

| A | | B | C | | |
|---|---|---|---|---|---|
| 75.98 | 145.98 | 70.98 | 69.98 | 119.98 | 172.98 |
| 77.98 | 150.98 | 72.98 | 71.98 | 126.98 | 175.98 |
| 79.98 | 151.98 | 73.98 | 74.98 | 127.98 | 176.98 |
| 83.98 | 152.98 | 78.98 | 76.98 | 131.98 | 179.98 |
| 85.98 | 156.98 | 80.98 | 81.98 | 132.98 | 180.98 |
| 87.98 | 157.98 | 82.98 | 86.98 | 133.98 | 182.98 |
| 92.98 | 158.98 | 84.98 | 88.98 | 134.98 | 183.98 |
| 93.98 | 159.98 | 89.98 | 90.98 | 139.98 | 184.98 |
| 100.98 | 161.98 | 94.98 | 91.98 | 141.98 | 185.98 |
| 104.98 | 163.98 | 98.98 | 95.98 | 143.98 | 186.98 |
| 105.98 | 168.98 | 101.98 | 96.98 | 147.98 | 187.98 |
| 110.98 | 173.98 | 106.98 | 97.98 | 148.98 | 188.98 |
| 113.98 | 174.98 | 111.98 | 99.98 | 149.98 | 189.98 |
| 120.98 | 177.98 | 116.98 | 102.98 | 153.98 | 190.98 |
| 121.98 | 178.98 | 122.98 | 103.98 | 154.98 | 191.98 |
| 123.98 | 181.98 | 124.98 | 107.98 | 155.98 | 192.98 |
| 125.98 | 196.98 | 129.98 | 108.98 | 160.98 | 193.98 |
| 128.98 | | 137.98 | 109.98 | 164.98 | 195.98 |
| 130.98 | | 140.98 | 112.98 | 165.98 | 198.98 |
| 135.98 | | 144.98 | 114.98 | 166.98 | 199.98 |
| 136.98 | | 146.98 | 115.98 | 169.98 | |
| 138.98 | | 162.98 | 117.98 | 170.98 | |
| 142.98 | | 167.98 | 118.98 | 171.98 | |
| | | 194.98 | | | |
| | | 197.98 | | | |

For the interferometer, the programs were classified in A, A/B, B and C category. The A programs will be scheduled in priority, A/B programs will be scheduled if feasible. Further time, if it becomes available, will go to the B programs, taking into account scientific merit, crowding in certain right ascension ranges and general aspects of balance. B programs will only be started in case of available observing time. Note that authors have to resubmit B projects which cannot be started in the winter period.

**Interferometer program ratings**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| I063 | B | I064 | B | I065 | C | I066 | C |
| I067 | B | I068 | B | I069 | A | I070 | C |
| I071 | A | I072 | C | I073 | A | I074 | A |
| I075 | C | I076 | C | I077 | B | I078 | C |
| I079 | C | I080 | C | I081 | C | I082 | B |
| I083 | B | I084 | C | I085 | C | I086 | C |
| I087 | B | I088 | A | I089 | B | I090 | A |
| I091 | B | I092 | A | I093 | C | I094 | A$^{\dagger}$ |
| I095 | A | I096 | A/B | I097 | C | I098 | C |
| I099 | C | I100 | C | I101 | C | I102 | A |
| I103 | B | I104 | C | I105 | C | I106 | A |
| I107 | B | I108 | A | I109 | C | I110 | A |
| I111 | C | I112 | B | I113 | C | I114 | C |
| I115 | C | I116 | C | I117 | C | I118 | C |
| I119 | C | I120 | C | I121 | A | I122 | B |
| I123 | A | I124 | C | I125 | C | I126 | A$^{\ddagger}$ |
| I127 | A$^{\ddagger}$ | I128 | A$^{\ddagger}$ | I129 | A$^{\dagger}$ | I130 | A |
| I131 | C | I132 | A | I133 | C | I134 | A |
| I135 | C | I136 | B | I137 | C | I138 | C |
| I139 | A | I140 | C | I141 | C | I142 | A |
| I143 | B | I144 | A | I145 | B | I146 | C |
| I147 | C | I148 | C | I149 | C | I150 | C |
| I151 | B | I152 | C | I153 | C | I154 | B |
| I155 | C | I156 | A | I157 | A | I158 | B |
| I159 | B | I160 | A | | | | |

$^{\dagger}$ programs with shared proprietary rights on data
$^{\ddagger}$ programs with shared proprietary rights on data and in collaboration with IRAM

*R. Neri & C. Thum*

# MM Interferometry Summer School

The first IRAM "MM Interferometry School" was held at the IRAM headquarters from Sep.14 to Sep.18, 1998. More than 60 people applied, and the school was attended by about 45 participants, mostly from European countries, but also from much farther (e.g. Australia), and this despite date conflicts with other important meetings both in France and Germany.

The first day was devoted to tutorials on millimeter radioastronomy and interferometry. On the second day, after 2 lectures, everybody departed for a visit of the Plateau de Bure interferometer. Despite adverse meteorological conditions which had transformed the "summer" school into a "winter" school (high winds and low temperatures on the Plateau de Bure), the visit was enjoyed by the participants. This long day was concluded in a more relaxed atmosphere by a dinner at the "Hotel de la Poste", half-way between Plateau de Bure and Grenoble.

Lectures restarted on the Wednesday, including a real-time interactive demonstration of the calibration system on selected data. Thursday was devoted to imaging problems. During the Friday morning, examples of practical applications were presented.

The participants, through the voice of a few volunteers, expressed their views on the school. The visit to Plateau de Bure, despite the constraints which it imposed on the schedule, was said to be important. Participants also appreciated the interactive presentation of the calibration, and suggested that such a system would be interesting to present practical aspects of the imaging process. Following this suggestion, and although this was formally after the closure of the school, the Friday afternoon was used for real-time demonstrations of some aspects of the imaging process.

Strong wishes were also expressed for a printed version of the lectures. IRAM intends to prepare a WEB version of most (if possible all) lectures, with an expected date of release of November 15.

Given the success of this school, and in view of the on-going projects for next generation mm arrays (MMA, LSA, LSMA), repeating this experience appears as an important next step. We anticipate that another school would be held during year 2000, presumably in September. However, we could consider organizing another school in 1999 if we receive enough requests.

In case you are interested, please contact Mrs.Berjaud (berjaud@iram.fr).

*S.Guilloteau*

# Scientific results

## Carbon monoxide emission as a precise tracer of molecular gas in the Andromeda galaxy

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([4]) IRAM, Divina Pastora 7, 18012 Granada, Spain

*Abstract*: We have mapped the CO 1–0 line emission over the soutwest half of M 31 with the IRAM 30-m telescope. The observations were made *on-the-fly*. The small beam-size, low sidelobe level and tight sampling yield a resolution (23″) and sensitivity (3 Jy kms$^{-1}$) unprecendented for a map of this size ($10^3$ armin$^2$). In addition, we have surveyed with the Plateau de Bure interferometer a few selected fields with a resolution of 2″ (9 pc).

The most striking results are *i)* the excellent correlation between CO and the dark lanes visible on the optical image (see figure on cover page), *ii)* the thinness of the molecular arms, *iii)* the good agreement between the CO and HI arm crests, *iv)* the detection of large streaming motions in the immediate vicinity of bright HII regions.

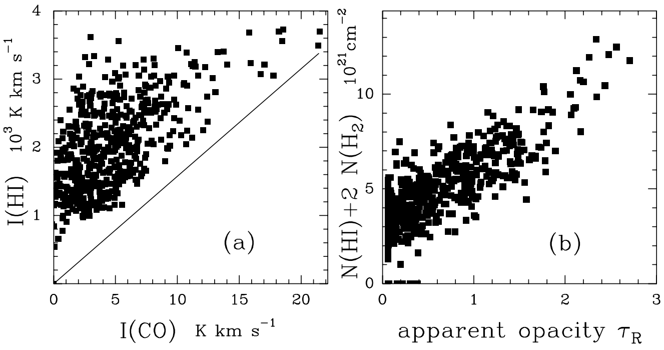


Figure 4: **a-** Relation between the CO and HI integrated intensities, I(CO) and I(HI), inside a 6 kpc-long, 1.5 kpc-wide lane centred on D 39 and following the southern $R$ = 11 kpc arm of M 31. Each point corresponds to a $\simeq$ 900arcsec$^2$ cell (5 $10^4$ pc$^2$ in the plane of M 31). **b-** Relation between the total hydrogen column density, estimated from I(CO) and I(HI), and the dust apparent opacity in the red.

It is often argued that the optically thick mm emission of $^{12}$CO does not trace the molecular gas properly and could be biased toward warm regions. The rich pattern of dust lanes visible throughout M 31's bright stellar disk yields another way to detect interstellar clouds, which does not depend on temperature or chemistry. Our high resolution CO map and the interferometric HI map of Brinks and Shane (A&AS 55, 1984) allow for the first time a detailed comparison of CO, HI and dust as tracers. All dark lanes with galactocentric radii $R \leq 15$ kpc are detected in CO. CO is always brighter where the extinction is larger, while HI can be bright in regions with moderate visual extinction.

This is illustrated in Fig. 4a which compares point by point the CO and HI velocity-integrated intensities $I$(CO) and $I$(HI) in the conspicuous $R \simeq 11$ kpc arm. Whereas HI is bright in many CO-dim regions with moderate visual extinction, CO is never observed where HI is faint, or the extinction is low. We have plotted in Fig 4b the total hydrogen column density, derived from the expression $N(\mathrm{H}) = 1.8\,10^{18}\,I(\mathrm{HI}) + 2.4\,10^{20}\,I(\mathrm{CO})$, as a function of the apparent visual opacity, $\tau_R$. $N$(H) is seen to scale with $\tau_R$: the slope is $3\,10^{21}$ H-atom cm$^{-2}$, close to that for the clouds in the solar neighbourhood. The linear correlation coefficient is $\rho = 0.80$, significantly larger than that obtained by plotting $I$(HI) or $I$(CO) alone ($\rho \simeq 0.7$). The good CO–dust correlation is a very strong indication that CO traces the H$_2$ column density. It also implies that a sizable fraction of the gas in the arm is in molecular form.

Nature *in press*. Pre-/reprints: nneini@astro.uni-bonn.de and guelin@iram.fr.

## $^{13}$CO at the centre of M 82

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*Abstract*: Using the IRAM interferometer, we have observed the nearby starburst galaxy M 82 in the 1→0 line of $^{13}$CO and in the continuum at 4.″2 resolution ($\simeq$ 70 pc). The spatial distribution of the $^{13}$CO line (Fig. 5) shows the same gross features as the $^{12}$CO(1→0) map of Shen and Lo (1995) – though with different relative intensities – namely two 'lobes' and a weaker 'central' source. In comparison, the 'lobes' are more conspicuous and the central source is fainter in $^{13}$CO than in $^{12}$CO. These lobes probably mark the end of a nuclear bar: the velocity field observed around the nucleus shows a very steep gradient (140 km s$^{-1}$ over 75 pc), the usual signpost of a bar. The dynamical center coincides with the strong IR peak and is shifted 6″ north-east of the 'central' $^{13}$CO peak.

The distribution and kinematics of the molecular gas is better described by gas flowing radially inward, rather than by a rotating molecular ring. The double-lobed morphology of the CO emission is explained in terms of dissociation of CO molecules by the intense and energetic radiation field in the central ∼250 pc region of M 82. Denser clouds as traced in the HCN line are better shielded against this radiation and have survived, thus making the contrast between the lobes and the central region much smaller in this line. This interpretation is in line with the bar scenario that ensued from previous observations in the near infrared.

A giant arc has been identified which happens to coincide with the most luminous compact radio source in M 82. It lies in a region between the central and the western lobe, which is void of CO gas. The whole region coincident with it is featured by warmer gas, strong free-free and C I emission as well as by an enhanced cosmic ray production rate. This ∼130 pc region must be a location of strong ionization and dissociation, except for gas locked in dense clouds.

Astronomy & Astrophysics *in press*. Preprint requests: N. Neininger, nneini@astro.uni-bonn.de

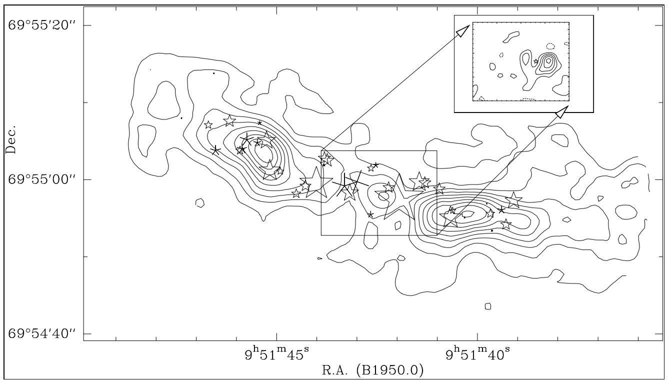


Figure 5: The figure shows the integrated $^{13}$CO(1-0) emission of M 82. The stars mark the positions of the point sources detected at $\lambda$ 6 cm, with their size scaled to the logarithm of the flux. Open stars are most probably SNR's; the oblique cross marks the position of the NIR center which is close to the dynamical center of M 82. In the lower left the derived rotation curve is shown together with the derived pattern speed and the locations of the Lindblad resonances. The kinematical signature indicates the presence of a bar. The upper right shows a channel map at the intrinsic rotation speed of −65 kms$^{-1}$. The star marks the strongest SNR wich lies in the middle of a giant bubble with a diameter of about 100 pc. This bubble is also prominent in other tracers including the low-frequency radio continuum.

## CO in absorption and emission toward compact extragalactic radio continuum sources

H. S. Liszt([1]) and R. Lucas([2]).
([1])NRAO, 520 Edgemont Road, Charlottesville, VA, USA 22903-2475
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*Abstract*: We have observed galactic $\lambda$2.6mm and $\lambda$1.3mm CO absorption and emission along nine lines of sight toward compact extragalactic mm-wave continuum sources, using the IRAM Plateau de Bure Interferometer and NRAO 12m telescopes. In absorption we detected some two dozen kinematic components, and nearly every feature known from HCO$^+$ spectra has a direct CO counterpart: a few CO lines are missing or very weak in emission even when $\tau$(CO) $\gtrsim$ 0.5. The column densities of CO and HCO$^+$ are well correlated, but not linearly related. The widths of the CO lines are typically 15% smaller than those of HCO$^+$ (on average 0.75 km s$^{-1}$ *vs.* 0.86 km s$^{-1}$).

We derive $^{12}$CO column densities $0.1 \lesssim N(^{12}\mathrm{CO}) \lesssim 20 \times 10^{15}$ cm$^{-2}$ which are in all cases very small compared to the column of carbon nuclei expected for 1 magnitude of visual extinction, even allowing for substantial depletion. The partial thermal pressure of $H_2$ is inferred to be $1000 \leq n(\mathrm{H_2})T_\mathrm{K} \leq 12{,}000$ cm$^{-3}$ K, with a median p/k = $3.2 \times 10^3$ cm$^{-3}$ K. Thus the clouds are likely warm ($T_\mathrm{K} \approx$

tens of K), somewhat diffuse ($n(H_2) \approx 50 - 300$ cm$^{-3}$), with the majority of the gas-phase carbon in the form of $C^+$ and perhaps even with a substantial fraction of H I in the thinnest cases.

The isotope ratios in the CO usually differ strongly from the local interstellar ratio which we have separately measured in these clouds to be $^{12}C/^{13}C = 60$ ; we find $15 \leq N(^{12}CO)/N(^{13}CO) \leq 54$, declining with increasing $N(^{12}CO)$. The $^{13}CO/C^{18}O$ ratio seen in emission or absorption is typically 25 (instead of 8) and $C^{18}O$ is very difficult to detect in emission even when $T^*_R(^{12}CO)/T^*_R(^{13}CO) < 10$. Apparently, the relative abundance of $^{13}CO$ is typically greatly enhanced, even at very low extinction, and never diminished by selective photodissociation. One effect of this enhancement is that lines of $^{12}CO$ are substantially less optically thick than might otherwise have been inferred. There is little evidence for a general selective depletion of $C^{18}O$.
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## Physical parameters of the Keplerian protoplanetary disk of DM Tau

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*Abstract*:
We present high sensitivity 3″ aperture synthesis images of the DM Tau protoplanetary disk in the CO J=1-0 line. The images unambiguously reveal that the disk is rotating around the central star. To model the observations in terms of a rotating disk in hydrostatic equilibrium, we have developped a $\chi^2$ fitting procedure which allows derivation of the disk parameters and their errors. Dependencies among the disk parameters are discussed in detail. The disk is large, with an outer radius of 850 AU. We find that the rotation curve is essentially Keplerian, at least up to 600 AU. The stellar mass derived from the rotation curve is $0.50 \pm 0.06 M_\odot (D/150\,\mathrm{pc})$. The intrinsic local velocity dispersion in the disk is found to be essentially thermal, with a turbulent component of less than 30 % of the thermal width. Parameters derived from this observation are used to confirm the molecular abundances and depletion factors estimated for several simple organic molecules by Dutrey et al (1997) for DM Tau.
Astron. Astrophys. *in press*. Preprints: guillote@iram.fr

## CO Study of the GM Aurigae Keplerian Disk

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*Abstract*: We report new high resolution ($0.6 - 1.7''$) images of GM Aur in the CO (2–1) line and the 1.3 and 2.7 mm continuum (see Fig. 6). The dust disk, located at the center of the CO disk, is resolved by the 0.6″ beam of the interferometer. We derive a minimum radius of $\sim 200$ AU, and a total mass (dust+gas) of about $\sim 0.025 M_\odot$. Our CO observations also resolve the Keplerian rotation of the gas disk. Since the CO emission is optically thick, the CO data does not allow a disk mass measurement but we can estimate the dynamical mass of the system, i.e. the *stellar mass*, $M_* = 0.84 \pm 0.05 \times (D/140\,\mathrm{pc}) M_\odot$ although a solution with a more inclined disk and lower stellar mass ($\sim 0.6 M_\odot$) is also possible.
Astronomy & Astrophysics Letter, *in press*. Preprints: dutrey@iram.fr

## A molecular jet from SVS 13B near HH 7–11

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*Abstract*: We present interferometric images of the $\lambda$ 1.3 and 3.5 mm continuum and the SiO J $= 2 \rightarrow 1$ emission towards the SVS 13/HH 7–11 vicinity (see Fig 7). The continuum data resolve SVS 13 into two components separated by $14''.5$ ($\sim$ 4300 AU) and having very similar millimeter properties: each of them has about 1 $M_\odot$ of circumstellar material and its emission is characterized by a spectral index of $\sim 2.5$. One of the components, SVS 13B, lacks optical, near infrared, or cm-wave counterpart, and is only detectable at millimeter waves, a fact that suggests it represents an extremely embedded, Class 0 object. This source, in addition, powers a remarkably collimated molecular outflow as seen by a high velocity SiO jet. HH 12, HH 16, and HH 352 lie along the line of this jet, suggesting they are also excited by SVS 13B. Our observations highlight the star-formation richness of the HH 7–11 region which contains in a small area some of the youngest and most extraordinary outflows known.
Astronomy & Astrophysics Lett. *in press* Preprint requests: bachiller@oan.es

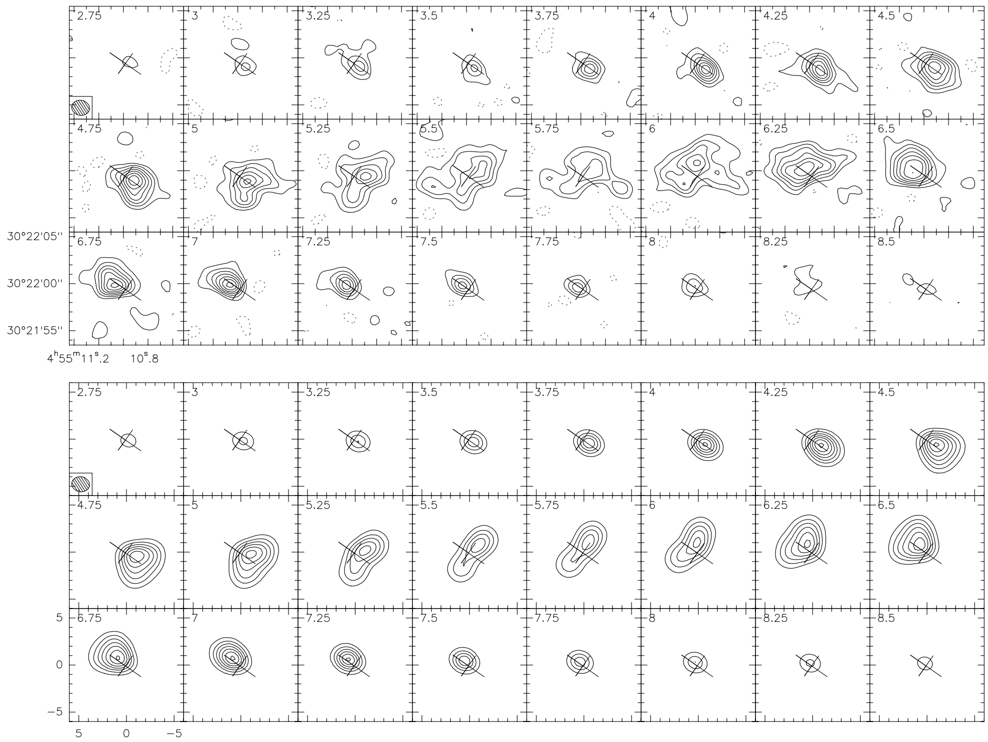

Figure 6: Channel maps of the CO data in GM Aur (top) and the best model processed in identical way (bottom). Contour steps are 0.25 mJy/beam (or 1.9 K). Velocities are indicated in the upper left corner of each panel .

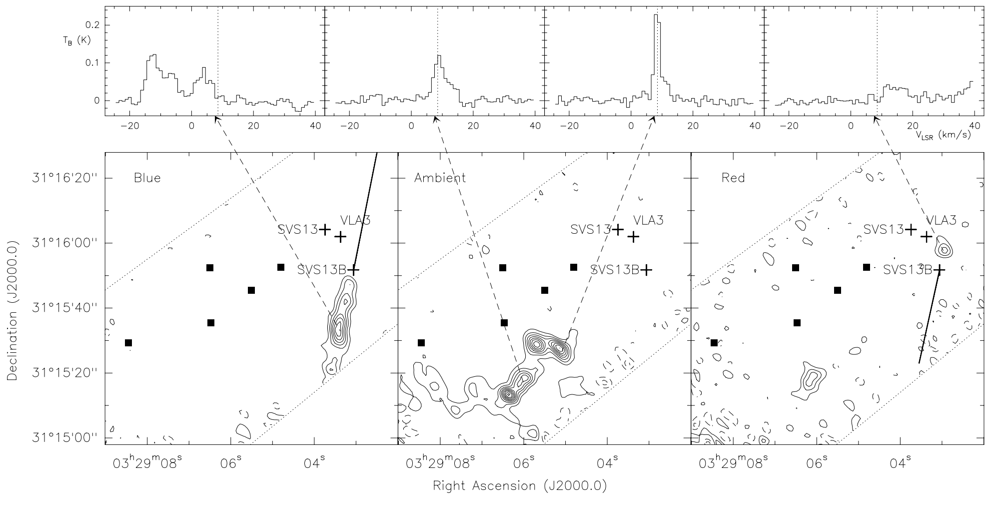


Figure 7: Channel maps of the SiO J = 2 → 1 line emission in SVS 13B/ HH 7–11 averaged over velocity intervals from -17 to 6.5 km s$^{-1}$ (left panel), from 6.5 to 10.5 km s$^{-1}$ (center), and from 10.5 to 17 km s$^{-1}$ (right). First contour and step are 10 mJy beam$^{-1}$. The positions of the HH 7–11 objects are marked by black squares. Some spectra obtained at particular map positions are shown in the upper panels. The direction of the SiO jet driven by SVS 13B is indicated by the thick lines in the high velocity maps.

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