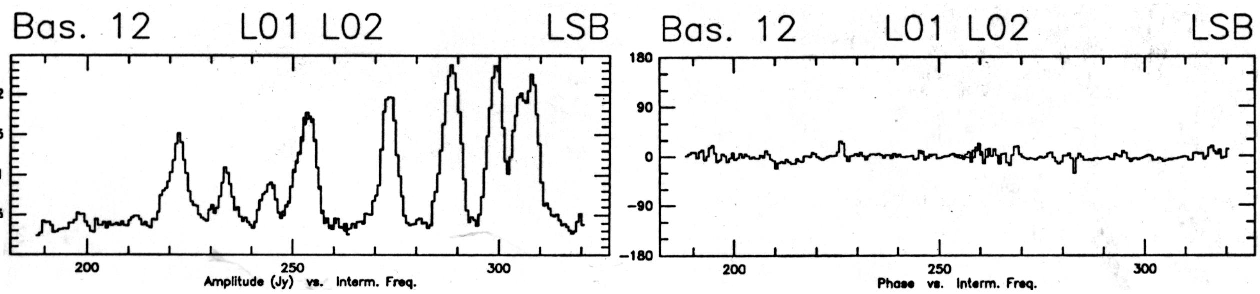
# IRAM 1992




## ANNUAL REPORT

**Front Cover :**

*Above :* The spectral correlator recently installed on the Plateau de Bure is a ring of six identical units, each of them offering tunable windows of 160, 80, 40, or 20 MHz bandwidth.

*Below :* Uncalibrated spectrum of $^{13}CH_3CN$ (methyl cyanide) from a molecular cloud near the HII region G31.2+0.3, taken with two units set to a bandwidth of 80 MHz. Only one baseline (1-2) is shown (6 are available).

# ANNUAL REPORT
# 1992

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# 1. INTRODUCTION

In 1992 both the 30m telescope and the Plateau de Bure interferometer have produced a wealth of scientific data. A summary of highlight results is given in the Chapter 2 of this report. In addition to many new scientific results, there have been two for IRAM "new" observing modes : the first Key Project has started which looks at pre-star forming clouds, and the first VLBI measurements with the 30m telescope have been made at 3mm (in addition to a second test experiment at 7mm). The Key Project has been chosen after an initial call for ideas and a subsequent call for proposals earlier in 1992.

On the technical side, the most important event was the successful completion of the mount for Antenna 4 for the Plateau de Bure Interferometer and the subsequent assembly and adjustment of the reflector. By December 1992 the entire mechanical structure of the telescope was ready, and soon thereafter the remaining, mostly electrical installations were completed, followed immediately by the first functional tests of the system. This new antenna doubles the number of instantaneous baselines and allows us do more efficiently projects like those which have been done so far, as well as new kinds of projects.

As reported before, there has been concern about the development of pinholes in the surface layers on top of the carbon-fibre panels of the Plateau de Bure reflectors, in particular on Antennas 1 and 2. In 1992, IRAM has conducted several studies in addition to closely monitoring this phenomenon, and we have come to the conclusion that there is no immediate impact on observations, neither at 3mm, nor at the next foreseen wavelength of 1mm. If and when an impact on the observations will be felt does, of course, depend on the further increase in the number of pinholes which continues to be monitored. Legally the issue was closed by signing agreements with the manufacturer and the IRAM insurance company in which financial provisions have been made for an eventual repair. In parallel, we have studied alternative surface materials and these studies are continuing, including tests outdoors.

In addition to a continuing upgrading and exchange of receivers, several new pieces of equipment have come into operation which include new digital correlator units at both observatories, and the IRAM single channel bolometer at the 30m telescope. The successful observations at both 7mm and 3mm with the VLBI terminal (cf. Chapter 2) made it clear that IRAM did not have the computer capacity to actually work efficiently on VLBI after they have been correlated at one of the centers. This led to the decision in December 1992 to buy two dedicated RISC stations, from the remaining money from the Volkswagen Foundation grant for VLBI equipment.

In November 1991, the IRAM Council had suggested that two study panels should be organised, one under the chairmanship of IRAM, one under the chairmanship of Professor R.Booth, to look at the scientific merits of (a) an extension of the Plateau de Bure Array to 6 antennas, and (b) a large array in the southern hemisphere. Results from both studies were reported to the new IRAM Visiting Committee which met in September 1992 in Grenoble and presented its findings to the IRAM Council in November. Amongst their recommendations, the strong encouragement to try and expand the current Plateau de Bure Array to 6 antennas is the most decisive for IRAM's further development.

# 2. HIGHLIGHTS OF RESEARCH WITH IRAM TELESCOPES IN 1992

## 2.1 SUMMARY

Here are some highlights of the many projects done at IRAM's observatories or published in 1992:

- Further study of the extremely luminous galaxy IRAS 10214+4724 at a redshift of 2.3: detection of this galaxy's dust emission at a wavelength of 1.2 mm gave an estimate of the dust mass; measurement of the ratios of the CO(3-2), (4-3) and (6-5) lines gave estimates of the gas temperature, density, and gas mass; an interferometer map gave a size of about 1" for the CO(3-2) source; a tentative detection of water vapour was reported.

- Measurement of $^{12}CO/^{13}CO$ intensity ratios of about 40 to 1 in several merging galaxies, in sharp contrast to the usual value of 10 to 1 in normal spirals. This may be evidence for the enrichment of the starburst regions by the nucleosynthesis products of massive stars.

- A new catalog of the millimeter flux variations of 107 quasars and radio galaxies; a new survey of CO(1-0) and (2-1) in 81 nearby spiral galaxies.

- A new limit on fluctuations in the cosmic background on 10" scales at 3.4 mm.

- Analysis of the CO(2-1) and (1-0) maps from the 30m telescope of the grand-design spiral galaxy M51 in terms of the density wave theory, and evidence for large streaming motions (up to 100 km/s).

- Interferometer maps of the 2.6 mm thermal emission of dust, probably in disks, around the triple star system UZ Tauri and the quadruple star system GG Tauri.

- Interferometer maps of SiO thermal emission from the L1448 outflow: analysis suggests the SiO clumps are shocks in a narrow jet that becomes collimated and accelerated to terminal velocity within 600 AU from the young star at the flow's origin. The continuum is emission from dust.

- Observations with the 30 m telescope showing the point source Sgr A* at the galactic center has a spectrum that rises steeply into the sub-mm range, suggestive of either a dust disk around a black hole or self-absorbed synchrotron emission from the black hole magnetosphere.

- VLBI runs with the 30 m telescope at 7 & 3 mm; among other results: a 7mm map of the jet in the radio galaxy Cygnus A and the first 3mm VLBI detection of the superluminal source 3C454.3.

- Interferometer maps of molecular lines, H recombination lines and the mm continuum in the surroundings of the compact H II region W3(OH), and the powerful $H_2O$ maser source 7"

Interferometer maps of molecular lines of CCH, $C_5H$, $C_4H$, $HC_5N$, NaCl, $SiC_2$, SiS and CO in the carbon rich stellar envelope IRC+10216, showing the different distributions of these species.

- Interferometer maps of $HC_5N$ and SiS in the pre-planetary nebula CRL 2688 showing the high velocity flow along the axis of the bipolar nebula and the low velocity flow in an expanding torus.

## 2.2 EXTRAGALACTIC RESEARCH

### Distant Sources (> 70 Mpc)

***IRAS 10214+4724: Are the Heavy Elements made in Starbursts?***

Further studies have been made with the 30 m telescope of the infrared ultraluminous galaxy IRAS 10214+4724 at a redshift of 2.286. Continuum radiation at 1.2 mm wavelength from warm dust in this galaxy was detected at a level of 10 mJy. This is the longest wavelength at which this galaxy's thermal continuum radiation has been detected. From the entire continuum spectrum (Fig. 2.1), the dust temperature is estimated to be 80 K, and from the optically thin radiation detected at the IRAM 30 m telescope, the dust mass is estimated to be 2.5 $10^8$ $h^{-2}$ solar masses, where $h$ is the Hubble constant in units of 100 km/s/Mpc. Measurements at the 30 m telescope of the ratios of the CO(3-2), (4-3), and (6-5) lines indicate the gas kinetic temperature is 50 K, the gas density is 5000 $H_2$ molecules per $cm^3$, and the total gas mass is 1x $10^{11}$ $h^{-2}$ solar masses. The ratio of the mass of gas (hydrogen plus helium) to warm dust is

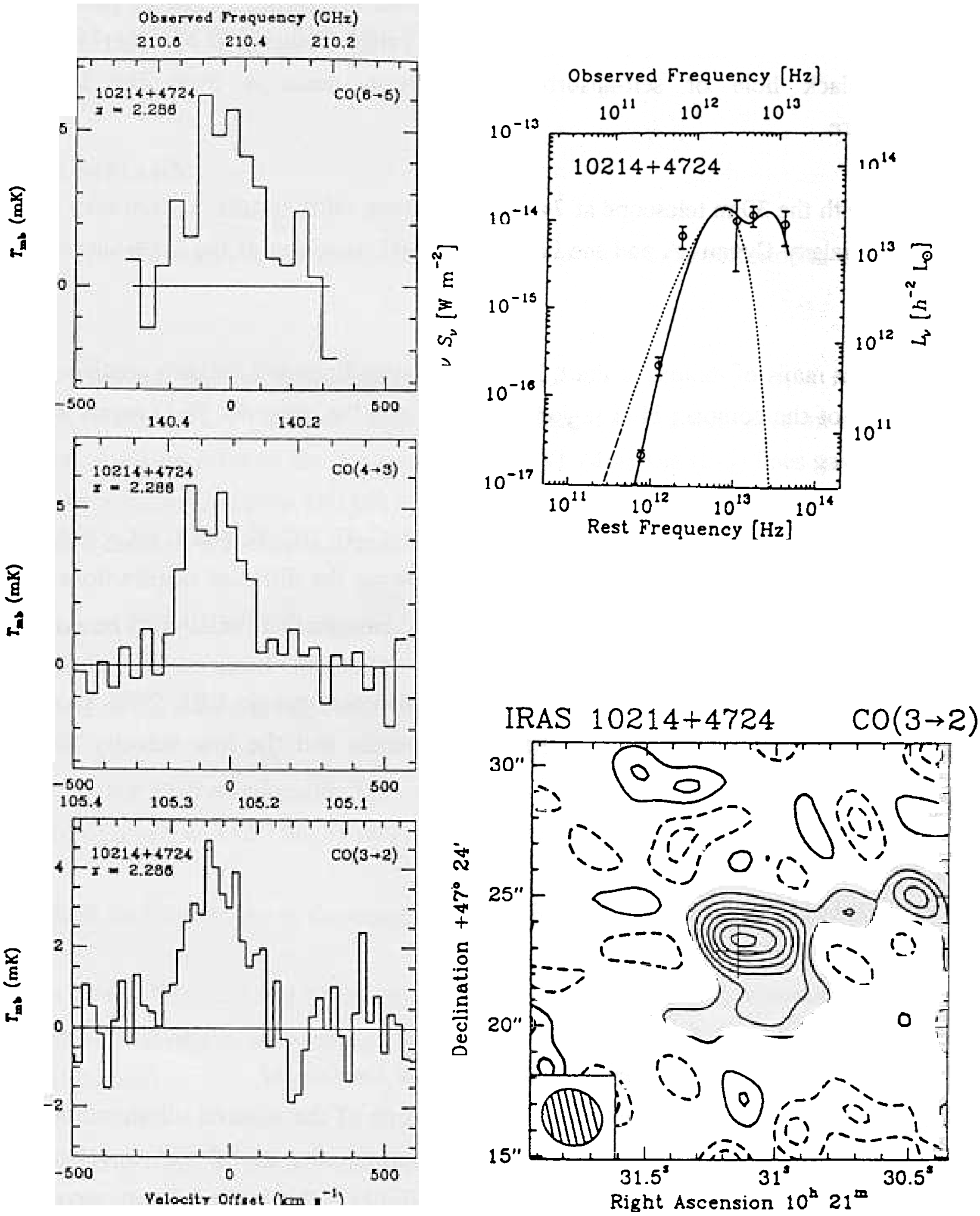



**Fig. 2.1:**

Results from IRAM telescopes on the infrared ultraluminous galaxy IRAS 10214+4724 at a redshift of 2.286. *Left column:* spectra of the CO(6-5), (4-3) and (3-2) lines, obtained with the 30m telescope. *Upper right:* FIR and submm continuum spectrum; the 30 m detection at 250 GHz is the lowest point on the curve, where the dust radiation is transparent. *Lower left:* IRAM interferometer map of the CO(3-2) emission.

500 to 1, surprisingly normal for such a high redshift galaxy. It is the same value as observed in the centers of nearby luminous galaxies that have solar metallicity. Hence in this galaxy, which is being observed when the universe was only a fifth of its present age, most of the heavy elements had already been produced, at nearly present-day abundances.

The CO(3-2) line from this galaxy has been mapped with the interferometer. The line source is small (1"), coincides with the radio continuum source mapped at the VLA and has the same CO(3-2) line flux as measured at the 30 m telescope. The interferometer map (Fig.2.1), made with a 2.3" beam, suggests the source is slightly extended EW, with an apparent velocity gradient due to rotation of the galaxy. Further interferometer data are needed to confirm this result.

### *10" Scale Isotropy of the Cosmic Background at 3.4 mm Wavelength*

A high declination field of empty sky was observed with the IRAM interferometer in a search for fluctuations in the temperature of the 2.7 K cosmic background radiation. The synthesized beam was 9" x 10" at a wavelength of 3.4 mm and the field of view was 55" in diameter. At the 95% confidence level, the upper limit to any fluctuations in the background is $\Delta T/T < 9\ 10^{-5}$. This is one of the best direct limits to date on cosmic background fluctuations at this resolution. Hence even with only three antennas, the IRAM interferometer is almost as sensitive a probe of the fine scale fluctuations in the cosmic background as is the VLA at longer wavelengths.

### *Missing $^{13}CO$ in Merging Galaxies?*

Observations with the 30 m telescope show the intensity ratio $^{12}CO/^{13}CO$ in merging galaxies is 30 to 1 and 40 to 1 in the CO(1-0) and CO(2-1) lines. In normal spiral galaxies the ratio is in the range 5 to 15. Starbursts in mergers yield high UV fluxes and $^{13}CO$ is more easily photo-dissociated than $^{12}CO$, but this does not explain the unusual ratio because $C^{18}O$ is as strong as $^{13}CO$. It should be even weaker than $^{13}CO$ if photodissociation were the explanation. The most likely reasons for this effect are 1) the merger process drives into the central regions a lot of outer galaxy gas, which has not been through much nuclear processing and still has a high $^{12}C/^{13}C$ ratio, and 2) the pile-up of gas in the center triggers a big starburst that forms predominantly massive stars, which quickly enrich the central regions in $^{12}C$. Hence these extragalactic ratios may be the first good evidence for nucleosynthesis, and not chemical fractionation, as the explanation for some variations in molecular line isotope ratios.

***First VLBI Runs with the 30 m Telescope***

Results of the initial VLBI runs at 43 GHz with the IRAM 30 m, Effelsberg 100 m and Onsala 20m telescopes include a map of the nuclear jet of the radio galaxy Cygnus A, which can be seen over a length of 4 milli-arcsec (Fig. 2.2), and confirmation of the apparent subluminal motion of the inner jet in the radio galaxy 3C84 (apparent motions 21,000 km/s near the nucleus to 114 000 km/s 4 milli-arcsec farther away). Other sources detected were 3C273, 3C345, 3C454.3, OJ 287, 0420-014, and the SiO maser in Orion IRc2. A first run at 86 GHz with the same telescopes gave detections of 3C273, 3C279, 3C345, 0528+134 and NRAO 530. The run also produced the first 3 mm VLBI detection of the well-known superluminal source 3C454.3.

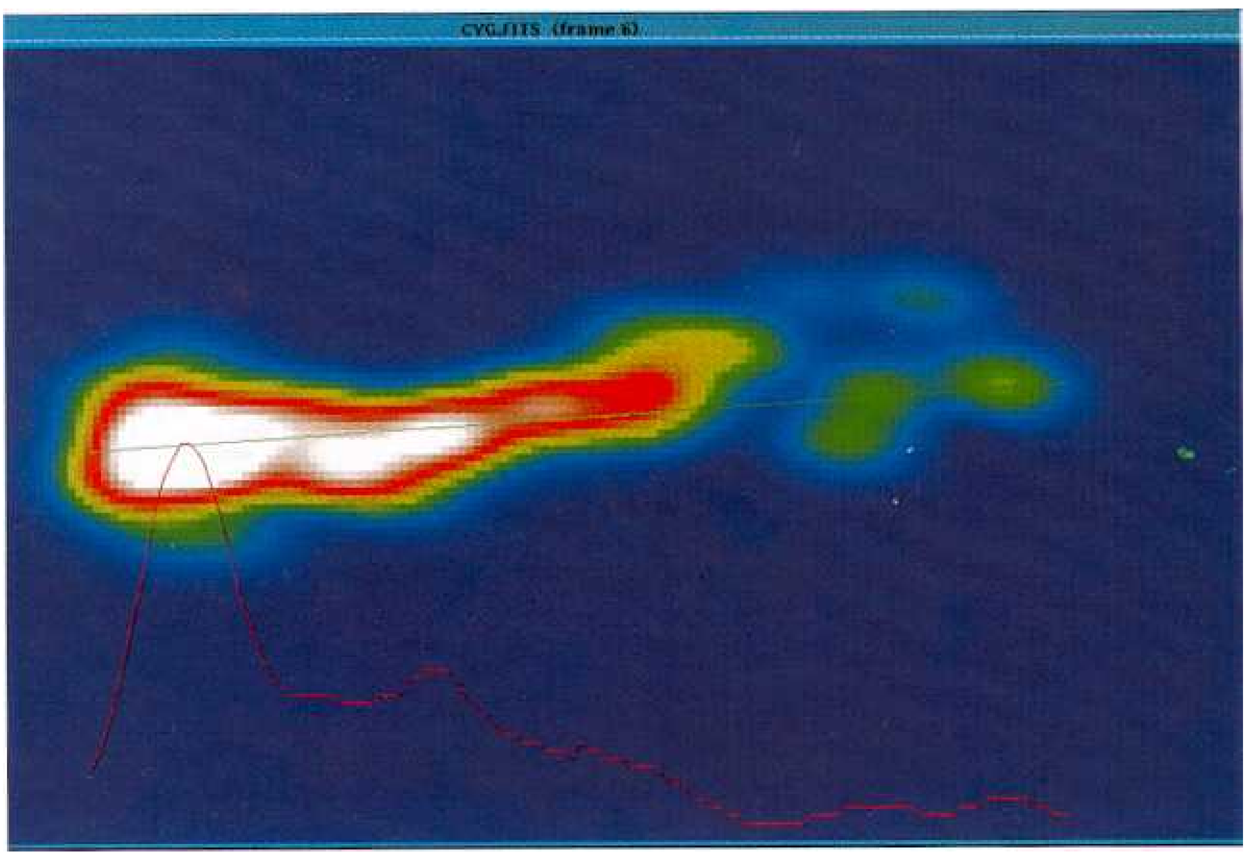


**Fig. 2.2 :**

VLBI map of the nuclear jet in the radio galaxy Cygnus A at 43 GHz. The area shown is 4 milli-arcsec NS and 7.5 milli-arcsec EW, and the resolution is 0.55 X 0.30 milli-arcsec. The bright peak has an intensity of 0.36 Jy/beam.

*Millimeter Flux Catalog*

A second IRAM catalog has been published of flux densities of 107 extragalactic radio sources measured at the 30 m telescope. The sources are mostly flat-spectrum quasars and a few radio galaxies with high flux densities at millimeter wavelengths. This second installment contains 30m measurements from 1987 through 1990. The publication also provides figures showing the millimeter flux variations of 52 sources from both the first and second IRAM catalogs, from 1984 through 1990. A third installment of this work has been submitted for publication as well.

### 2.2.2 Nearby Galaxies (10 < D < 70 Mpc)

*A CO(1-0) and (2-1) Survey of Nearby Spiral Galaxies*

A survey of 81 nearby spiral galaxies in the CO(1-0) and (2-1) lines has been published. Both lines were detected in the centers of 36 of the galaxies. The overall detection rate was 75%, including 18 new detections. The mean CO(2-1)/(1-0) ratio is 0.9, consistent with optically thick gas in both transitions, with the exception of the center of the starburst galaxy NGC 3310, where the ratio is 2.6, higher than in M82. Off-center CO maxima were found in one-third of the galaxies. The high resolution cuts show that the previously used exponential disk is not a good model to the true CO distributions.

*Dynamics of Molecular Clouds in M51*

The molecular gas dynamics in the spiral galaxy M51 have been studied on the basis of maps made with the 30 m telescope in the CO(1-0) and (2-1) lines (Fig. 2.3). The molecular spiral arms stretch almost continuously from the nuclear disk of 1-kpc radius to 8 kpc, the radius of co-rotation of the stars and the spiral pattern. The CO velocity field shows large departures from circular rotation, consisting of streaming motions near the arms and near the center, and of random motions as well. The streaming motions in the arms can be followed in CO in the interarm region from one arm to another. These motions have the direction and behaviour predicted by the density-wave theory inside co-rotation, and may be as large as 100 km/s. The gas clouds in the inner nuclear regions also have non-circular motions, probably due to elliptical orbits.

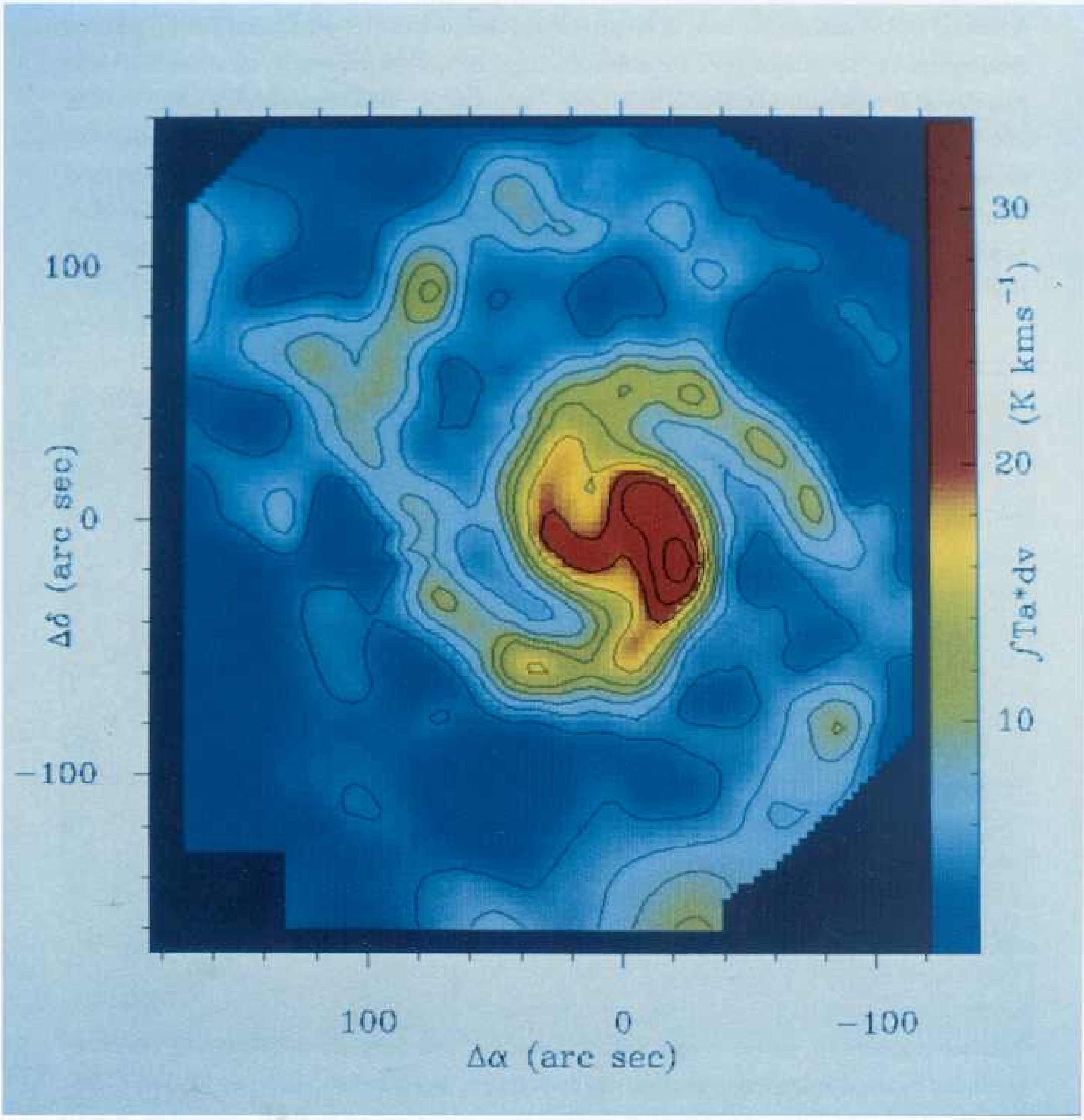



**Fig. 2.3:**
Map of the grand design spiral M51, made in the CO(2-1) line with the 30 m telescope. The resolution is 12". The intensity scale runs from 1 K km/s to 33 K km/s.

### 2.2.3 The Nearest Galaxies ( < 10 Mpc )

***Molecular Gas Distribution and Dynamics in the Edge-on Spiral NGC 891***

The edge-on spiral galaxy NGC 891, mapped in the CO(1-0) and (2-1) lines with the 30 m telescope, shows molecular gas over the whole 24 kpc length of the major axis and up to 1.4 kpc above and below the galactic plane. Most of the CO is in a ring with a central hole of radius 2 to 3 kpc, inside which is a rapidly rotating nuclear disk of radius 250 pc. Most of the gas is in the galactic plane, in a disk less than 300 pc thick, in both dense cores and diffuse envelopes, with about half the molecular mass in the envelopes. There is also a halo of molecular gas, seen weakly in the CO(1-0) line, that is 2 to 3 kpc thick, with a radius > 7 kpc.

***A Large $^{12}C/^{13}C$ Ratio in the Nucleus of NGC 253***

Toward the starburst in the nucleus of the nearby galaxy NGC 253, six carbon bearing molecules --CO, CN, CS, HCN, $HCO^+$, and HNC have been observed in their $^{12}C$ and $^{13}C$ species to constrain the possible range of carbon and oxygen isotope ratios. Analysis yields $^{12}C/^{13}C$ equal to 40 to 1, and $^{16}O/^{18}O$ equal to 200 to 1. These ratios are similar to those measured in the more extreme starbursts in mergers, and provides additional evidence for enrichment of the medium by high-mass stars. This study also resulted in the first detections of $^{13}CS$ and the $0_0$--$1_{-1}$ line of methanol outside our Galaxy.

***$HCO^+$ in the centers of the Galaxies IC 342 and Maffei 2***

The IRAM interferometer has mapped the center of the galaxy IC 342 in the $HCO^+$ line and the center of the galaxy Maffei 2 in both $HCO^+$ and HCN. Both galaxies' centers were also mapped in the 3.4 mm continuum. A study of these maps is in progress, with comparisons with previously published data in the isotopic lines of CO.

## 2.3 THE GALACTIC CENTER

Observations with the IRAM 30 m telescope show the point source Sgr A* at the Galactic center has a sharply rising spectrum at short millimeter wavelengths. Throughout most of the centimeter range, this non-thermal source has a flux density of about 1 Jy, which is fairly constant with time, with variations of the order of 30%. At a wavelength of 1.3 mm, however, its flux rises to 2.6 Jy, and at 0.87 mm, it is even higher, 4.8 Jy. This spectrum, rising into the submillimeter range, may indicate either thermal radiation from an optically thick dust disk of outer radius $10^{17}$ cm surrounding a black hole at the galactic center, or else non-thermal radiation from a self-absorbed synchrotron source of size $6\ 10^{12}$ cm, possibly the magnetosphere of the black hole. High resolution sub-mm interferometry is needed to help decide between the two models suggested for this new component in the galactic center.

## 2.4 YOUNG STELLAR OBJECTS

### 2.4.1 Outflows

***The L 1448 Outflow***

The SiO v=0, (2-1) thermal emission was mapped with the interferometer in the central region of the L 1448 outflow. The SiO is in a highly collimated bipolar jet of four very well aligned high velocity clumps, of sizes <2" x 4", elongated along the axis of the outflow (Fig. 2.4). The symmetric northern and southern jets are blue- and red-shifted, respectively, by 70 km/s relative to the ambient cloud. The velocity and spatial structure of the clumps and their high content of SiO molecules suggests the clumps are successive shocks in the narrow jet. The jet becomes collimated and accelerated to terminal velocity within a distance of 600 AU from the young star. The SiO lobes determine the kinematic point of origin of the outflow, which coincides within 100 AU of a radio continuum and infrared point source. The millimeter continuum radiation is dust emission associated with 0.1 to 0.6 solar masses of gas. The velocities and positions suggest the material in the youngest clump in the outflow was ejected only 100 years ago.

***The Outflow Source near W3(OH)***

The IRAM interferometer has been used to map the surroundings of the compact H II region W3(OH) in the continuum and in the molecular lines of $C^{18}O$, $CH_3CN$, and $HCO^+$, and the hydrogen recombination lines H41$\alpha$ and H59$\gamma$. Continuum emission is detected from the compact H II region and from a much weaker source 7" east. The recombination lines indicate an east-west velocity gradient of 7 km/s across the H II region, which has a diameter of 2" (0.03 pc at the 3kpc distance of W3(OH). All three molecular line maps show emission in the dense molecular clump 7" east of the H II region. This eastern clump is the site of the strong water vapour masers which have a wide spread in velocity characteristics of a powerful outflow source. At this position, the methyl cyanide line observations with the interferometer indicate a temperature of 100 to 200 K. This temperature and the continuum flux from the dust correspond to a mass of 30 solar masses for the dense clump, which probably contains a young OB star still surrounded by a very thick cocoon of dust.

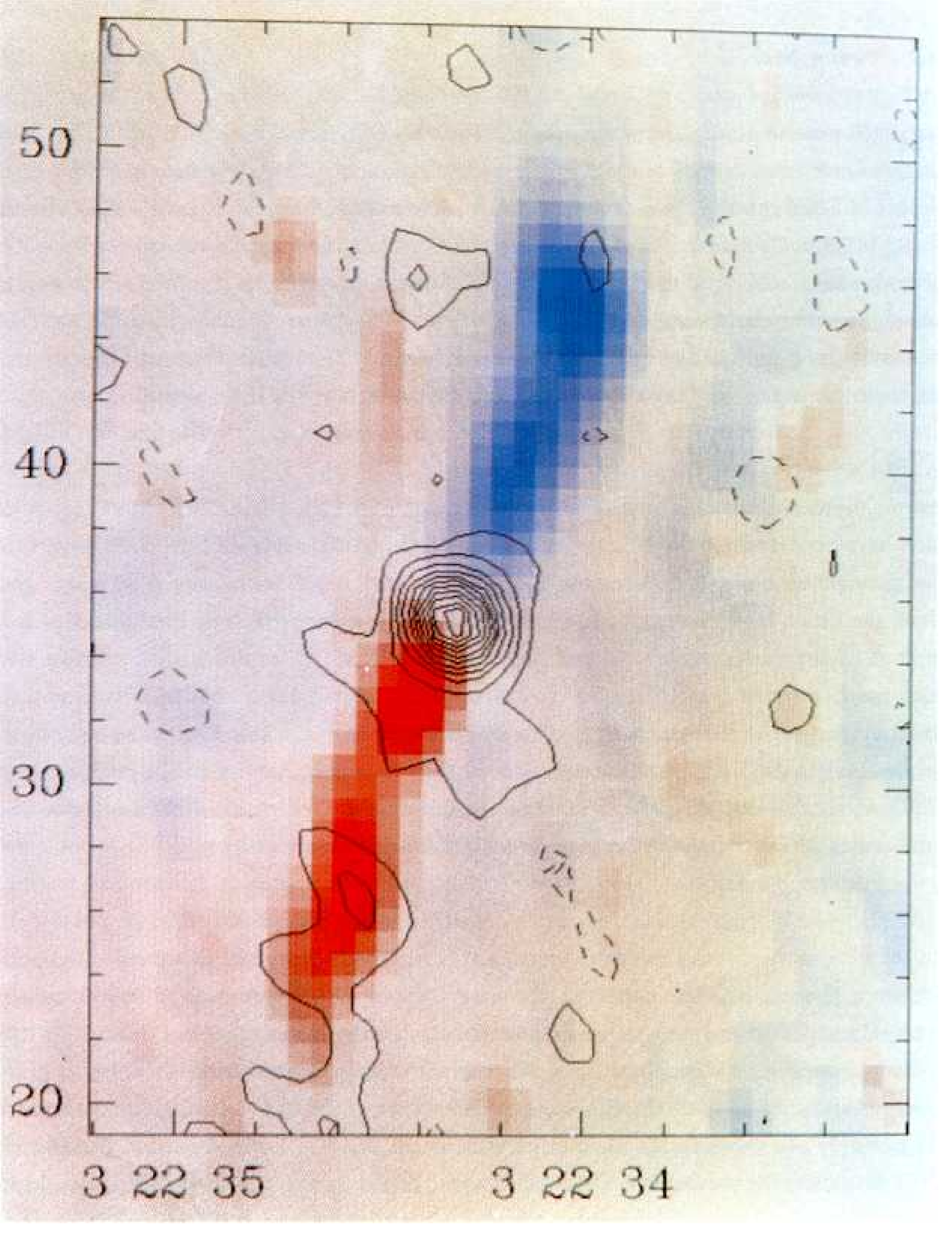



**Fig. 2.4:**
Interferometer map of the SiO v=0, J= 2-1 emission in the highly collimated outflow source in L1448. The northern and southern jets are blue- and red-shifted, respectively, by 70 km/s relative to the ambient cloud. The contours show the 3.4mm continuum emission by dust. Resolution = 2.2 arcsec.

### 2.4.2 Young Stars

***Dusty Disks in the Multiple Star Systems UZ Tauri and GG Tauri***

Interferometer observations of the 2.6 mm thermal emission from dust around the triple star system UZ Tauri show an even partition of dust between the close binary star UZ Tau W and the star UZ Tau E. The dust is partly opaque at 2.6 mm, implying an origin in disks of size 13 AU and mass 0.024 solar masses. In the quadruple star system GG Tauri, there is strong emission from dust extending over 3" x 5", associated with the close binary star GG Tau, and weak emission from GG Tau/c, another close pair of stars. Dusty disks can evidently survive near close binaries of the T Tauri type for at least $10^5$ years after the stars' formation.

***NGC 2024***

New multi-line observations toward the mm continuum peak FIR 5 in the NGC 2024 region in Orion have been made at the 30 m telescope and at the JCMT in Hawaii. Nine different CO lines gave physical parameters for the source. Most of the column density is in warm gas behind the Orion B H II region. The low intensity of low J isotopic CO lines excludes the presence of large amounts of cold gas. Maps made in four CO transitions indicate that the warm gas has a spatial distribution very similar to that of the 1.3 mm dust continuum. A significant part of the 1.3 mm continuum is therefore likely to come from warm dust embedded in warm gas, heated by internal sources. Consequently, an interpretation of the compact mm continuum sources including FIR 5, in terms of isothermal protostars and significant depletion of molecules onto dust grains is not supported by the new measurements.

***S 106***

The source Sharpless 106 is a compact, bipolar H II region whose two lobes are separated by a dark lane. The exciting star appears to be a very young object that may be still accreting matter. Earlier observers had suggested that the dark lane was caused by a cold (<20 K), massive (20 solar mass) disk about 30" in diameter, in which molecules had been depleted onto grains. Maps of $^{13}CO(2-1)$ and CS(3-2) have been made at the 30 m telescope and combined with CO(6-5) and submm continuum maps made at the JCMT. These combined IRAM and JCMT data show the previously unresolved dust lane breaks up into a number of sources; there is no evidence for a smooth disk about the star. Consistent column densities can be derived from the dust and line emission with standard molecular abundances and modest dust temperatures (50 K). This suggests most of the circumstellar dust and gas is *warm*; no significant molecular depletion has occurred.

*Rho Ophiuchus Cloud*

A survey of the dust emission of the densest parts of the Rho Oph cloud has been carried out with the MPIfR bolometer on the 30 m telescope. Detections include three structureless cores with hydrogen densities 4 $10^5$ to $10^6$ / $cm^3$ and masses ranging from 1 to 15 solar masses. Another more complex core has also been found that contains four high-density ($10^8$ / $cm^3$ ) condensations with masses ranging from 0.3 to 3 solar masses. These condensations may be low-mass protostars. One of the condensations is associated with a highly collimated gas flow and an ultra-compact H II region. The number of detections of candidate protostars is only one-tenth of the number of T Tauri stars (78) in the same region, suggesting the lifetime of such objects is only 40,000 years, one-tenth the duration of the T Tauri phase. This may explain why real protostars are relatively rare and hard to find.

## CIRCUMSTELLAR ENVELOPES

### 2.5.1 Chemistry and Dynamics of Star Envelopes

*Sulfur-Bearing Molecules in O-Rich Circumstellar Envelopes*

A survey of the molecules of sulfur dioxide, $SO_2$, and hydrogen sulfide, $H_2S$, in oxygen-rich circumstellar envelopes has been carried out with the 30 m telescope. Both molecules were detected in all 14 stars surveyed, with multiline detections in most of them. The lines of $SO_2$ were found to be optically thin with a rotational excitation temperature of 25 to 40 K, as predicted by models of photosynthesis in the outer envelope. The rotational temperature of $H_2S$ is larger, 50 to 100 K, and its linewidths are narrower. This suggests the $H_2S$ lines are emitted in inner layers of the circumstellar envelope that may not yet have reached their final outflow speed. A major question is how much sulfur is in the gas and how much is in the dust grains, especially since the sulfur compounds in the solid state are rather fragile. This new study with the 30 m telelescope shows the abundance of sulfur in the *gas phase* of O-rich circumstellar envelopes is certainly large, probably at least 50% of the solar abundance.

### Post Red-Giant Stages

*Maps of IRC+10216*

The infrared object known as IRC+10216 is a well known circumstellar envelope of an evolved star. It is very familiar to millimeter astronomers because of its extremely rich spectrum of molecular lines. More than 50 different molecules, including highly refractory compounds and highly reactive species have been identified in the dusty envelope.The IRAM interferometer has

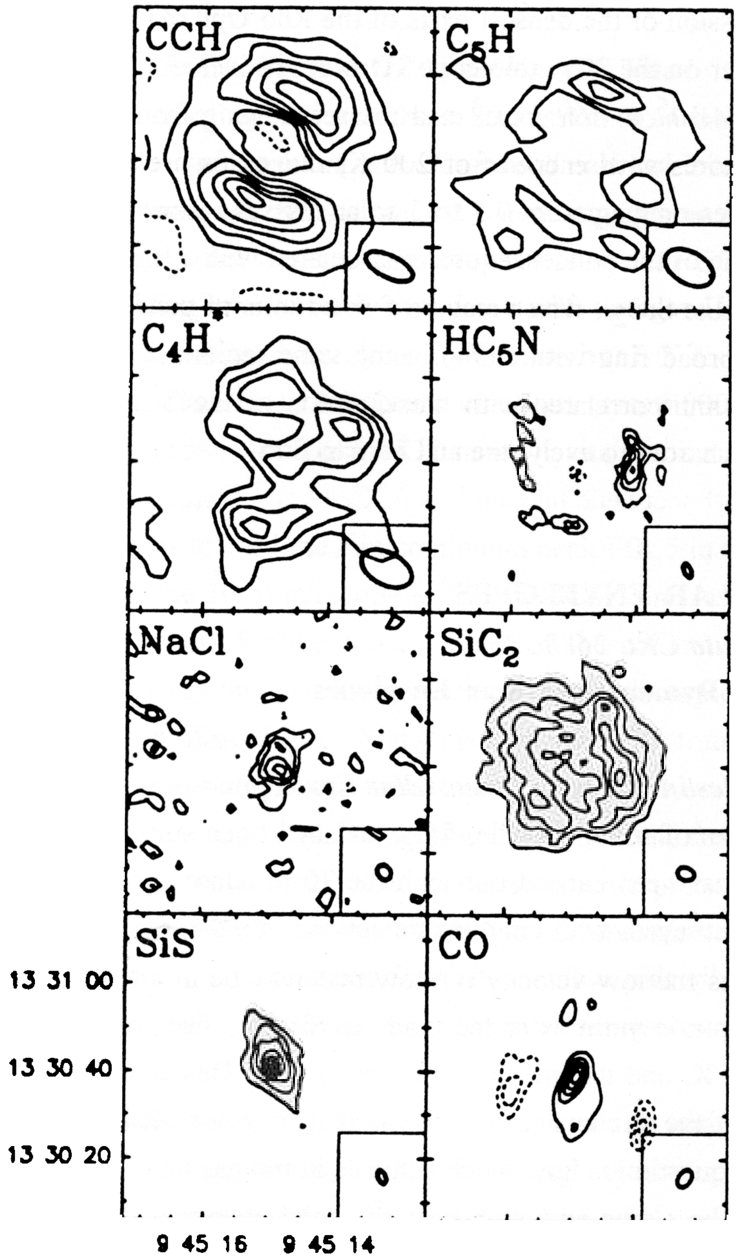



**Fig. 2.5**

Maps of the circumstellar envelope of IRC+10216 made with the IRAM interferometer. Each box shows the emission in a different molecular line in a 5 km/s velocity interval centered on the star's velocity. Small boxes in the lower right corner of each map show the half-power beam. The CO map at lower right shows only the inner dense regions, not the well-known strong CO emission in the very extended envelope.

now mapped the carbon-rich envelope of IRC+10216 with a resolution of 3" to 5" in several molecular lines (Fig. 2.5). For CCH, the interferometer map was combined with a fully sampled map from the 30 m telescope, and shows a clumpy ring. The $C_5H$ and $C_4H$ ($v_7$) maps also show a hollow shell with a radius of 20", where the temperature is 20 K. Since the $C_4H$ line comes from levels with energies of 200 K, the states are probably excited by IR radiation. The $HC_5N$ is in a very thin shell. The highly refractory NaCl molecule extends along a SE-NW axis, possibly the direction of the strongest mass loss from the stellar atmosphere. The molecule $SiC_2$ , which may be formed in both the star's atmosphere and its outer envelope, is in a broad ring with clumps due to variations in excitation or abundance. These $SiC_2$ clumps are anti-correlated with those of CCH, possibly because $SiC_2$, with its higher dipole moment, is harder to excite than CCH or possibly because the chemistry changes, with photo-dissociation of acetylene making lots of CCH at a certain radius. The SiS is in the inner part of the envelope, as had also been shown with the Hat Creek array.

***The Pre-Planetary Nebula CRL 2688***

CRL 2688 is the prototype for the class of objects known as pre-planetary nebulae. Like other objects in its class, it has a bipolar outflow, from which many molecular lines have been detected with single dish telescopes. The line profiles differ from species to species. Some of the lines like CO, HCN and SiS show high velocity wings. Maps of SiS and $HC_5N$ have been made with the IRAM interferometer. The 3 mm continuum flux is 170 mJy, with a size of 2". The SiS emission is compact, and shows the high velocity flow along the axis of the optical bipolar nebula, as well as the low velocity outflow that may be in an expanding and rotating torus. The $HC_5N$ emission is more extended than the SiS emission, and may be in a hollow, expanding shell.

## 2.6 MOLECULES

### 2.6.1 New Molecules

***Interstellar $CH_2DOH$***

Five transitions of the $CH_2DOH$ form of deuterated methanol have been detected at frequencies ranging from 92 to 227 GHz with the 30 m telescope. All lines were found in a 15" region located 8" SW of the luminous infrared source Orion IRc2, in the so-called Orion compact ridge. Earlier observations with the 30 m telescope had detected 13 transitions of another form of deuterated methanol, $CH_3OD$, with a relatively high degree of fractionation, namely $CH_3OD/CH_3OH$ = 0.01 to 0.06 ! [The cosmic D/H ratio is 0.00001] . This was about ten times higher than the deuterium isotopic ratios for water and ammonia in Orion. A likely explanation for deuterium enhancements is molecule formation on grain surfaces at low temperatures. Some chemical reactions involving D atoms are favored at low temperatures because they have lower energy thresholds than similar reactions involving H atoms. Alternatively, the molecules might form in gas rather than on surfaces of dust grains, but then various chemical reactions would yield different abundances for different kinds of deuterated methanol.

The result of the 30 m observations is that the two forms of deuterated methanol are equally present. The abundance ratio of $CH_2DOH$ / $CH_3OD$ is about one. Since there is no reason why the addition of deuterium atoms to radicals on grain surfaces should favor either deuterated form of methanol, these observations may be taken as evidence for formation of these molecules on grain surfaces.

There is a remaining mystery, however: why are these deuterated molecules near the source IRc2, where IR data show dust temperatures > 100 K, too hot for molecules to form on grains ? One possibility is that they formed at low temperatures (<40 K) before the star in IRc2 formed. When IRc2 turned on, the rising temperatures could have driven methanol into the gas, where it is now detected.

### 2.6.2 Astrochemistry

*Abundance of Nitric Oxide in TMC 1*

Detection with the 30 m telelescope of the lines of the nitric oxide molecule near 150 GHz in the Taurus dark cloud TMC 1 shows that its abundance relative to hydrogen is $NO/H_2$ = 2.7 $10^{-8}$, about 8 times less than in L134N, another dark cloud where NO has been previously observed. This large variation in abundance for such a simple molecule may be due to two different causes, either different degrees of depletion onto dust grains for C, N, and O, or else constant depletions but greatly different time scales for mixing processes. Both effects probably contribute, enhancing chemical differences between dark clouds, and throughout an individual cloud.

# 3. PICO VELETA OBSERVATORY

## 3.1 Staff Changes

The year 1992 has seen a significant number of staff changes which required special efforts from the remaining staff and the newly recruited staff to guarantee a smooth transition and continued support of the telescope operation, and, in addition, special support for newly arriving equipment ans for special observing runs (e.g. VLBI). The staff changes involved: 2 astronomers, 1 cooperand, 1 operator, 1 operator/technician, and 1 receiver engineer.

## 3.2 30-m Telescope Operation

The operation of the telescope was smooth throughout 1992, without major mechanical or electrical failures. Only minor repairs were necessary, caused by normal wear and tear of structural components and electric/electronic equipment. These could be executed to a large extent during the regularly scheduled telescope maintenance periods of approximately 12 hours per week which coincide with the periods set aside for receiver fillings/maintenance and test tunings.

All these activities together with regular pointing tests once per week, which take 5 - 6 hours each, absorbed approximately 25 % of the annually available telescope time. This includes several larger blocks of time for the installation and test of new receivers (345 GHZ receiver, IRAM bolometer), the preparation and execution of VLBI runs, and holography measurements. Unfortunately, the month of December 1992 has seen an accumalation of problems in the receiver operation (230 G1, 2 mm, bolometer) which unfortunately affected several guest observers' programs.

For the majority of astronomical projects we were able to test the necessary receiver tunings well in advance thanks to the availability of a sufficient number of receiver engineers at the telescope. This preparatory work clearly increases the observing efficiency and should be continued in the future. This will be feasible as long as the frequency requests do not become too excessive ! The Granada astronomers provided throughout the entire year assistance in the observations, taking care also of pointing and calibration measurements.

The pointing parameters of the telescope have been regularly updated. We normally achieve an accuracy of 2 - 3", however, the pointing may severely be degraded after a heavy storm.

### 3.3 Infrastructure

By the end of 1991 we had reached a reassuring situation where we had two water supply lines in operation. However, the original line which had been in use since approximately 10 years broke during the 1991/1992 winter period because of extreme and unexpected wear of the PVC tubes. The repair of this line will not be an easy matter because it is embedded in a particularly steep mountain slope. The Laguna, which has been a major concern two years ago, has been rebuilt and should now guarantee a stable water supply - as long as the general water shortage in the south of Spain does not affect us.

The electrical power supply worked without major interruption, despite the heavy construction work executed by CERTURSA in our close neibourhood.

The exterior of the telescope tower, the observatory building and the entrance to the garage have been completely renovated during the summer period. The work involved sanation and painting of the exposed concrete of the telescope tower, complete painting of the observatory building, sealing of the window frames, and pavement of the garage entrance.

The road to the observatory between the cable car station Borreguiles and the telescope is in several places still in rather poor condition; repair work in 1992 has been confined to the protection rails in the bends.

Special attention has been given to safety aspects, concerning both people and materials. The fire alarm system has been upgraded by installing several new sensors, and by placing it under a professional maintenance contract.

### 3.4 Reflector Surface

39 GHz phase retrieval holography measurements, using the geostationary satellite ITALSAT at 43 degrees elevation, have been made in April (2 days) and November (4 days) 1992. In the April measurements the system was set up and checked for future application; the November measurements suffered severely from snow, wind, and some technical problems. The position of the satellite was determined by dedicated observations at Yebes which are gratefully acknowledged.

The satellite holography revealed astigmatism, which was independently detected from cross-scans through in-and-out-of-focus radio images. The astigmatism is not found in the 3 mm phase retrieval holography using the transmitter on Pico Veleta at 11 degree elevation.

Test revealed that the astigmatism is produced by a corresponding geometrical deformation of the main reflector. The deviation at the edge of the reflector is ~ 0.1 mm. However, the surface-averaged deformation is small (rms ~ 0.035 mm) and the precision of the 30-m reflector (rms ~ 0.075 mm at ~ 50 degree elevation) is still determined by the accuracy of the panel adjustment.

Unfortunately, the holography made in November did not provide data of sufficient quality for a new panel adjustment; currently, the 7 mm receiver has been returned to the MPIfR for repair and improvement. Further surface measurements will therefore be delayed until the second or third quarter of 1993.

### 3.5 Receivers

The 3 mm Schottky (pointing) receiver - one channel - can no longer be tuned because of a defect LO-coupler, whereby we have lost the possibility to observe at the (very) low frequencies. Unfortunately, there is a delay in the repair of the receiver because of an extreme delay on the side of the manufacturer in the repair of the spare mixer.

In August, the 3 mm SIS was equipped with a new Nb-junction mixer and has shown since then reliable and improved performance (Trx(SSB) below 100 K at 100 - 115 GHz). The new mixer required the installation of a 1.5 GHz IF.

After reliable and satisfactory operation, the Pb-junction of the 2 mm SIS receiver lost contact in December. A Nb-junction, new for this receiver, was installed, and the receiver shows good performance, as can be judged from the limited experience so far.

The 230 GHz G2 receiver (Nb-junction, narrow band: 215 - 250 GHz) worked well during the whole period. A new HEMT amplifier was installed in August.

The 230 GHz G1 receiver (Pb-junction, broad band: 210 - 265 GHz) gradually degraded during the year (instabilities, higher noise temperatures, change in tuning settings). In November we therefore decided to equip this receiver with a new Nb-SIS junction broad band mixer which has shown good performance in the laboratory. However, the re-start of this receiver has caused problems.

The IRAM 230 GHz - one -channel bolometer and data acquisition system was tested at the telescope and provided to the astronomers in two observing runs, in February - March and November - December (15 - 20 days periods each).

The Rothermel 345 GHz receiver (SIS open structure) was tested at the telescope and made available to guest observers in March. Unfortunately, the good performance of this receiver was not fully exploited because of frequent poor weather conditions.

The 7 mm Schottky receiver (MPIfR) was used for VLBI observations, and also for holography measurements. The receiver is at the MPIfR for repair and improvement.

The project of the NRAO-mixer receiver was cancelled

The MPIfR observed with their 230 GHz 7-channel bolometer array and the 230 GHz bolometer-polarimeter.

The project of a Martin-Puplett interferometer for (remote) USB - LSB calibration, for all receivers, has advanced to the production state, the installation is planned for early 1993.

A prototype unit for a remote tuning control had been delivered to Grenoble in November 1991. The remaining development and construction work has so far, unfortunately, not been completed.

Although we usually achieve, and maintain for considerable time, the alignment of the receivers within ~ 3 ", occasionally the alignment is lost by unknown reasons.

### 3.6 VLBI

Successful VLBI observations including several European and American stations were made on 23 - 28 May at 7 mm. VLBI test observations at 3 mm were made on 7 - 10 July together with Effelsberg and Onsala.

The staff of the backend group, the computer group, and the digital electronics group assisted in the operation of the VLBI terminal.

## 3.7 Backends

Two autocorrelators, built at IRAM Grenoble, were delivered to the telescope in January. With this delivery we terminated the operation of the Berkeley correlator.

In close collaboration of the backend group and the receiver group, the correlators were installed and incorporated at the telescope within 3 months, and starting in May some restricted observations were offered to the astronomers of 20 MHz bandwidth, one receiver per correlator. After further development of the control and data acquisition software, the correlators were made available in July for regular observations of 20, 40, 80, 160, 320, 640 MHz bandwidths, one receiver per correlator. From the beginning the correlators could be used with the wobbler.

Although there exists a problem with the correlator chips, a program is available for immediate localization of a faulty chip, allowing subsequent repair - as long as spares are available.

The multitude of backends: two 512 MHz filterbanks (one with split mode), one 100 KHz filterbank (with split mode), one 500 MHz AOS, two correlators (both with split mode), requires an up-dated receiver-backend connection and control. The backend group of Granada therefore designed and constructed a new distribution box which will be installed early 1993. This unit will allow a computer controlled distribution of the IF outputs (now 4) to the backends (now 6), with the possibility to use also the correlators in split mode.

In a collaboration of staff from all groups the precision of the LO reference system was improved so that the high resolution (20 MHz) of the correlators can be fully exploited.

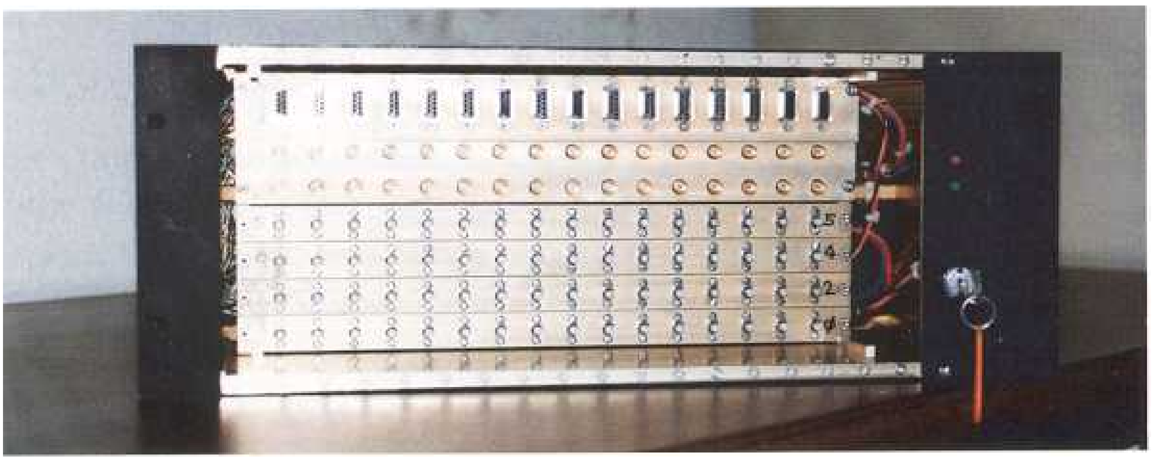
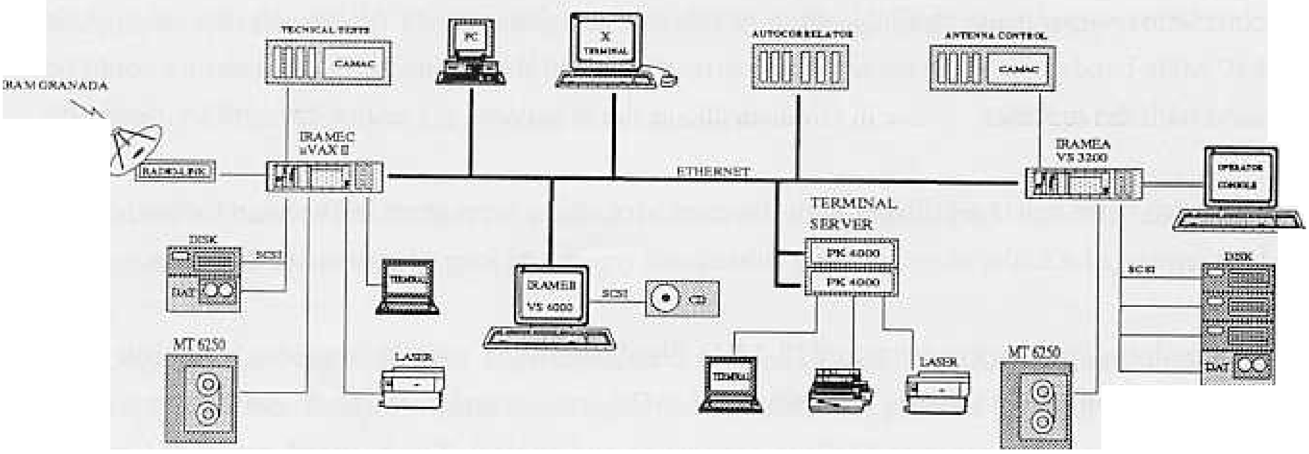


**Fig. 3.1:**
The new distribution box designed and constructed by the Granada backend-group.

## 3.8 Computer system and software

The telescope control computer was replaced in summer for a VaxStation 3200, which implied an increase in computing speed by a factor of 2.5. The old disk drives were replaced by SCSI disks increasing thereby the disk space and the flexibility to add more drives.

LAN COMPUTER ON PICO VELETA
30M RADIOTELESCOPE




LAN COMPUTER ON IRAM GRANADA

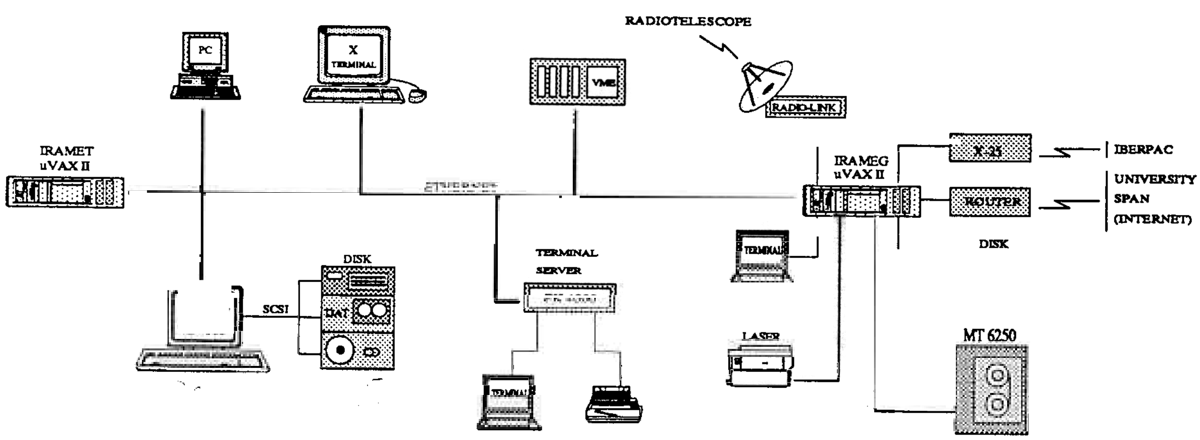



**Fig. 3.2:**
Schematic overview of the computer networks available at the 30m telescope and in the IRAM Granada offices and laboratories.

A VaxStation 4000/VLC was installed at the telescope in order to improve off-line data reduction. Another VaxStation 4000/VLC is available at the Granada office; it can be used by visitors, for instance for remote observing. DAT tapes were installed and are available for the visitors at the telescope and the Granada office.

We have started to replace the old graphical terminals by X-Window terminals and Ethernet is now accessible from all offices in Granada and the telescope, including the receiver cabin. A VME crate has been installed in Granada for technical development and tests, this system is integrated into the local network. It is foreseen to install in 1993 another crate in the observatory laboratory.

CD-ROM drives are available in Granada and at the observatory, being connected to the Vaxes and one PC. The maintenance contract with Digital was changed in order to receive Vax documentation on CDs. Several astronomical catalogs are now also available on CDs.

New software products were installed on the Vax and the PC-network. Computer Aided Software Engineering tools from Digital (VaxSet) are available, and it is planned to use them for new developments as well as for revising "old" software.

Network software was installed which connects the different systems (VAX/Vms, PC-MSDOS, PC-Unix, VME/OS9, terminal server) and gives access to the X25 data network. A permanent link to the University of Granada Computer Center was installed, and this will give access to SPAN and Internet in 1993.

The software for remote observing was improved; it includes now a program that displays on a VaxStation in the Granada office a colour copy of the colour monitor of the telescope control.

### 3.9 Administration - Granada Office

The accounting (investment, running costs, etc) was changed to a new system that runs on a Compac AT under SCO Unix. The staff of the administration now uses AT computers instead of terminals.

The Granada office organized the lodging in the IRAM-IGN residencia, the transport to and from the telescope, and the logistics at the telescope for approximately 250 visitors.

# 4. PLATEAU DE BURE OBSERVATORY

## 4.1 Interferometer Status

1992 has been an important year for the interferometer. Several major improvements were made, among which:

the most significant progress for the users has been the installation of the new, flexible correlator built by the backend group (see also section 5.2). It replaces the old Berkeley-type spectral correlator and the 4-bit continuum correlator. Despite an unanticipated high rate of chip failure, its ease of maintenance and global reliability are a major improvement for smooth operations on Plateau de Bure.

The use of the new correlator permitted to refine the optimal effective IF bandwidth of the receivers, which is typically 130-620 MHz.

The second major improvement has been the continuing effort on the receivers. The SIS on antenna 1 received a new mixer block, providing more reliable operation, and the "old" but faithful Schottky receiver has been replaced by a SIS receiver. All antennas now provide typical system temperatures $T_{LSB} \leq 150$ K below 100 GHz. $T_{LSB}$ increases to 200-250 K at 110 GHz. Unfortunately, at 115 GHz, the system temperature degrades to about 600 K (depending on weather conditions). This degradation is due both to the atmosphere and to the impossibility of LSB tuning at this frequency.

All antennas were adjusted by holography to about 75 μ accuracy. The repeatability of the holography measurements indicates a clear possibility for further improvements, which were not attempted since they are not necessary at 3 mm.

Progress continues (although slowly) on the pointing. New inclinometers are now in operation, and it becomes clear that the main pointing problems are due to thermal drifts in the fork of the antenna.

The de-icing systems on all antennas was reviewed, with a special effort to improve the heating of the sub-reflectors and quadrupod legs but also to replace many of the first generation heating matraces.

All antennas were equipped with ultrasonic devices as anti-collision protection.

Antenna 4 construction proceeded on schedule, and the reflector assembly was finished late December 1992.

## 4.2 Infrastructure Improvements

Concerning the cable car, the decision was taken to change the counter weight, thereby reducing the amplitude of its movements, and to adjust the length of the main cables accordingly. This should avoid further deformation problems which occurred in the past from the moving counter weight.

New snow cleaning equipment was bought which allows a much more rapid cleaning of the tracks.

## 4.3 Observing Projects

After two years of operation, the Plateau de Bure interferometer has fully completed 47 projects. The exceptionally bad weather period during the fall of 1992 delayed quite significantly a number of projects, so that early 1993, 15 projects were still awaiting completion. These numbers confirm the throughput estimate of 25 to 30 projects per year mentioned in the last report for the 3-antenna system.

The distribution of the 62 projects per country is the following:

| Country | By First Authors |
|---|---|
| IRAM | 13.0 |
| Germany | 17.0 |
| France | 18.0 |
| Spain | 7.0 |
| USA | 7.0 |
| Other | 0.0 |

These numbers are a relatively poor representation of the effective use of the interferometer, since projects range from small detection experiments carried out by one or two astronomers, to large, multi-national collaborations equivalent to several complete syntheses.

Per category of projects, the distribution is the following

| | |
|---|---|
| Star Formation | 16 |
| Circumstellar Envelopes | 16 [1] |
| Galaxies | 13 |
| Others | 17 |

[1] including one project equivalent to several syntheses

Compared to last year, we note a much wider range of topics covered by the interferometer, as well as many more scientific groups applying for observing time. This broader variety is not reflected in the per-country distribution of successful proposals.

The first scientific papers based on Plateau de Bure observations have now appeared, and we expect a much larger number of publications in 1993 since many projects are now fully reduced.

### 4.4 Data Analysis

The advent of the new correlator has required a significant upgrade of the CLIC package. As usual, the upgrade has been made in an upward compatible way. The new CLIC version completely handles the 6 units of the correlator, with 4 antennas, and is also able to process data coming from the old correlator system. Special care has been taken to handle phase closure relations and broad-band signals ("pseudo-continuum" channels) in order to leave open the possibility of self-calibration and hybrid mapping when the 4 antennas will be operational.

Less visible progress also happened for the mapping stage, with the development of a more flexible, interactive, CLEAN-based deconvolution program, and, in collaboration with the Observatoire de Grenoble, a completely redesigned version of the GreG plotting package. These facilities are now undergoing final testing and will be released as standard part of the GILDAS package in the course of 1993.

# 5. GRENOBLE HEADQUARTERS

## 5.1 SIS GROUP AND RECEIVER GROUP ACTIVITIES

### 5.1.2 Junction Fabrication

*100 GHz*

More junctions were made with integrated tuning circuit

*150 GHz*

Some more junctions were prepared still without integrated tuning.

*230 GHz*

For the first time integrated tuning was incorporated for waveguide receivers for the IRAM telescopes and for a quasioptical receiver development. The waveguide junctions are also incorporated in the POM2 receiver.

*345 GHz*

More junctions, without integrated tuning structure, were made for the MPIfR.

For the first time, devices with integrated tuning were fabricated for an IRAM waveguide receiver.

Some junctions with a new antenna design were made for the quasioptical receiver of the MPE.

### 5.1.2 Junction Fabrication by Visitors

Junctions for 350, 460 and 600 GHz with tuning circuit and integrated in a logarithmic periodic antenna have been made in our laboratory by a member of the MPIfR. A member of the MPE fabricated junctions for 690 GHz with tuning circuit integrated in a V-antenna.

### 5.1.3 New Junction Developments

*Double-Barrier Junctions*

One way to reduce the electric capacitance of the mixer is to use planar series arrays. The leads connecting the individual junctions of such an array can prevent coherent operation of the array. We have started to prepare vertical arrays, as a first step only double barrier junctions (Fig. 5.1). Such devices are packed so closely that they should operate coherently even at very high frequencies. They are also of interest for other applications such as three-terminal devices, oscillators or X-ray counters.

*Sub-micron Junctions*

Another way to reduce the capacitance of the mixer is to employ sub-micron junctions. Junctions as small as 0.4 $\mu m^2$ were made by replacing the standard square or round resist stencils for junction definition by small resist lines. Such lines withstand better the various process steps. Fig. 5.2 illustrates the fabrication of a two-junction array using resist lines.

*Thermal Annealing*

It was found that the resistance $R_N$ of Nb-Al/Aloxide-Nb junctions can be increased by thermal annealing between 200 and 240°C. This effect can be utilized to adjust the $R_N$ value after fabrication, but it also shows that $R_N$ is sensitive to temperature rises in the various fabrication steps.

*NbN Junctions*

The sputter system was installed, and the optimization of the sputter parameters for the NbN electrodes and the MgO tunnel barrier has been started.

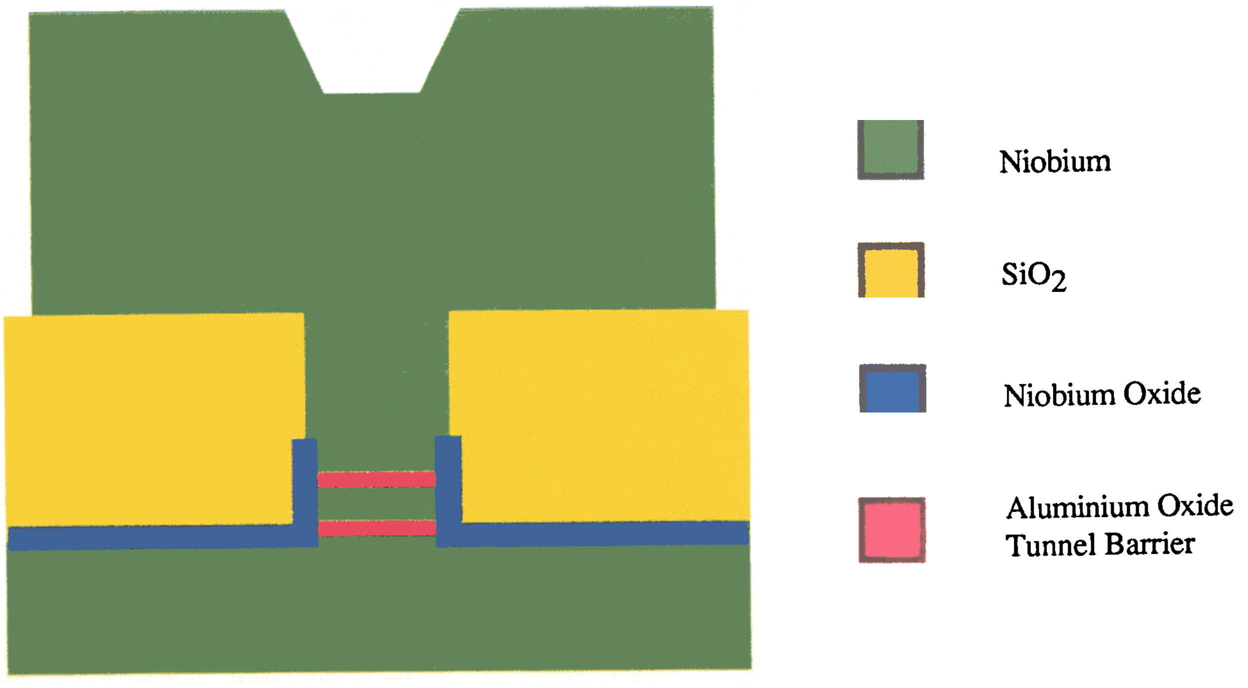



**Fig. 5.1:**
Schematic cross-section through a double-barrier junction.

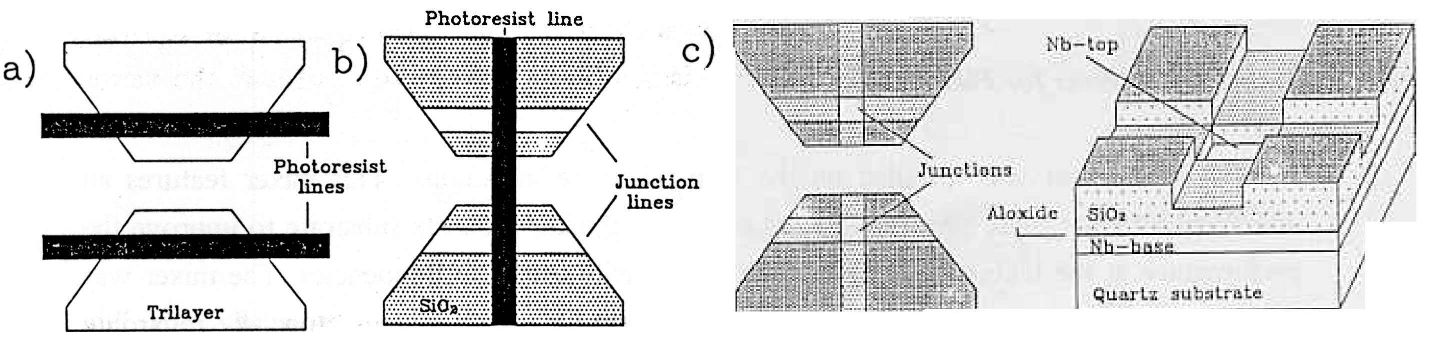



**Fig. 5.2:**
The use of photo-resist lines for the construction of sub-micron junctions.

### 5.1.4 New Receivers and Upgrades at the Telescopes

*3mm Receivers for the Plateau de Bure Interferometer*

In May 1992, the 3mm Schottky receiver on A2 was taken out of service. A complete SIS receiver system was installed: cryostat, warm IF, control electronics, chopper, etc. An identical receiver system was prepared for A4; at the time of writing, it is installed on the site. Noise temperature curves of all four 3mm receivers on PdB are shown on Fig. 5.3. The receivers can be tuned SSB (lower sideband) at most frequencies. *System* temperatures (on the $T_R^*$ scale) as low as 120K have been obtained.

*Bolometer for Pico Veleta*

A single-channel bolometer, called IBOL-B, was built in 1991 with the help of the MPIfR bolometer group. This bolometer was successfully tested in February 1992, and offered for regular scheduled observations for two weeks in March. A second session of scheduled observations took place in November; some technical problems were met, but overall the session was successful, including the commissioning of a new set of post-detection electronics. The instrumental sensitivity is 70 mJy $s^{1/2}$; the actual sensitivity depends, of course, on atmospheric conditions. The 3-dB beamwidth is 12.5". A detailed account of the testing and performance of IBOL-B can be found in IRAM working report No.212/92.

*3mm SIS Receiver for Pico Veleta*

A new 3mm mixer was installed on the 30m telescope in August. This mixer features an interstandard waveguide size (WR-9) and a reduced thickness quartz substrate to improve the performance at the high end of the band, at the heavily used CO frequencies. The mixer was extensively tested in the laboratory before installation on the telescope, especially regarding USB rejection. The 3mm receiver now uses a 1.5 GHz IF (made by Yebes Observatory) to achieve the best possible noise. The performance recorded during regular use at the telescope is shown on Fig.5.4.

*1.3mm SIS Receiver for Pico Veleta*

Following the development of inductively compensated junctions, a 1.3mm mixer using such junctions was subjected to extensive tests in the laboratory, and gave good results (100-160K SSB over 200-270 GHz). That mixer was installed on the telescope in December

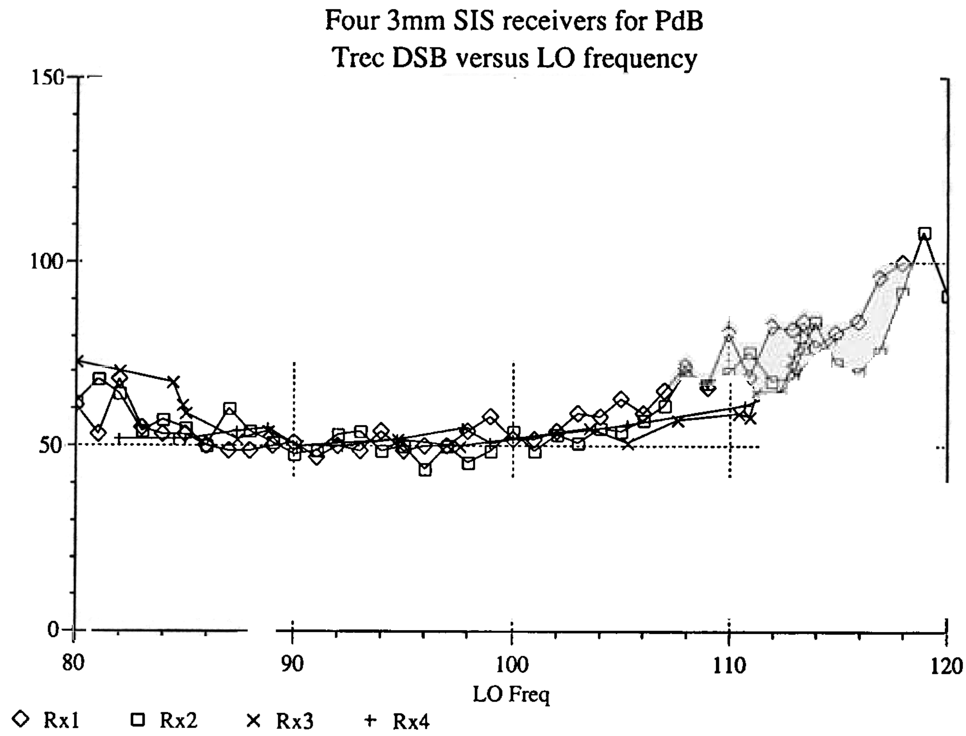



**Fig. 5.3:**
The four 3mm SIS receivers for the PdB interferometer. Note the remarkable reproducibility of performances.

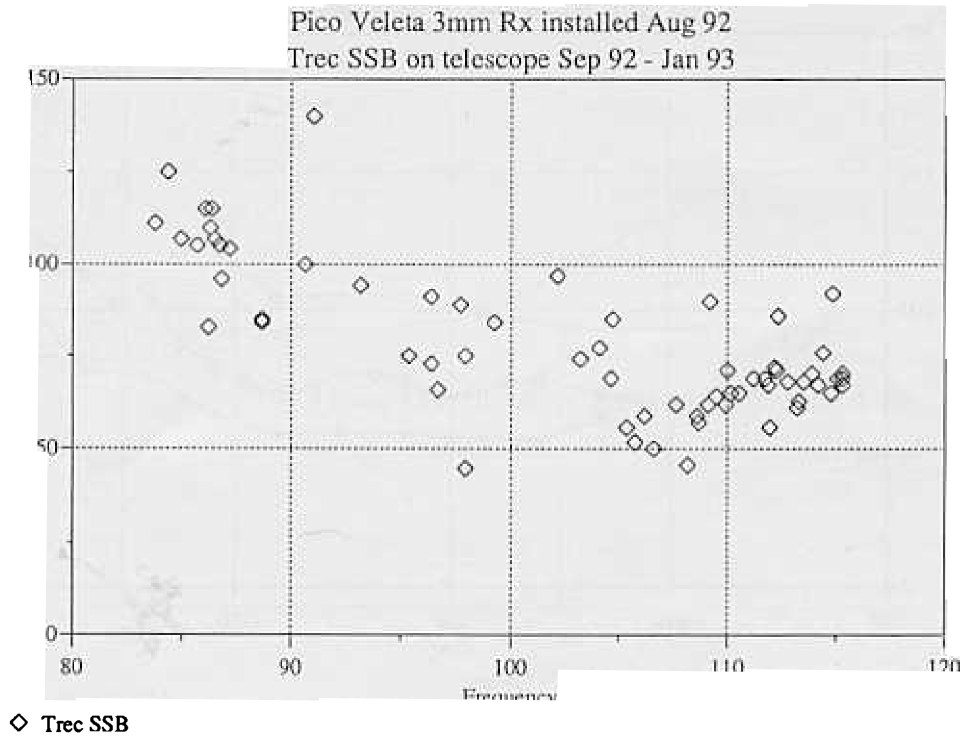



**Fig. 5.4:**
SSB receiver noise of the 3mm receiver installed on the 30m telescope in August 1992. This mixer has been specially optimized for the CO lines.

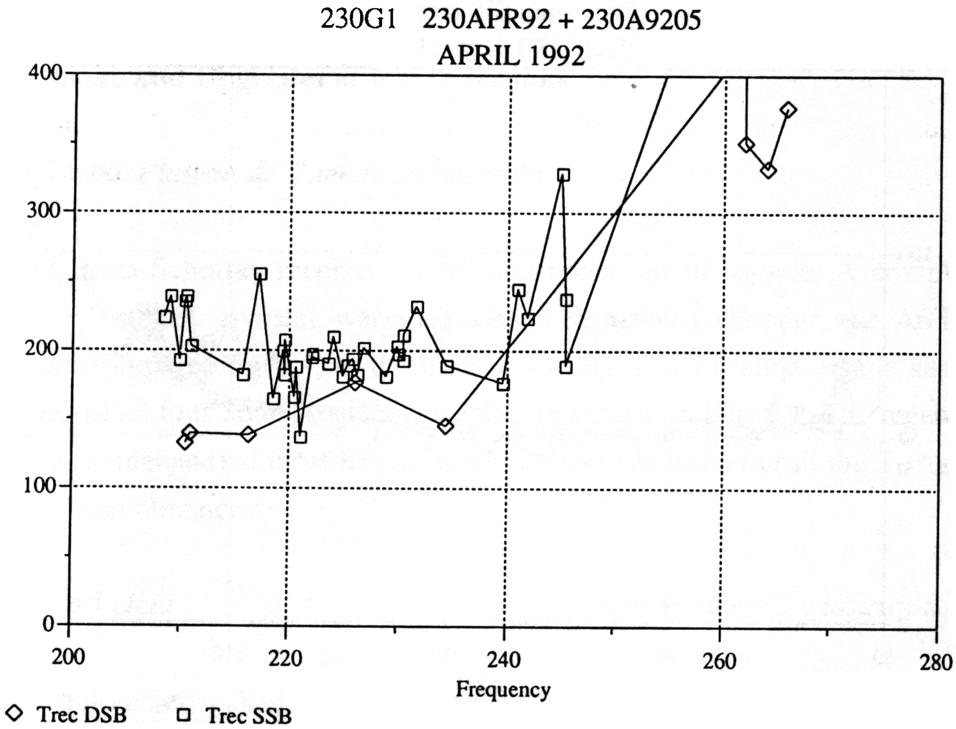



**Fig. 5.5:**
Receiver temperature (SSB and DSB) of the 230G1 receiver on the 30m telescope *before* the new mixer with an inductively compensated junction was installed.

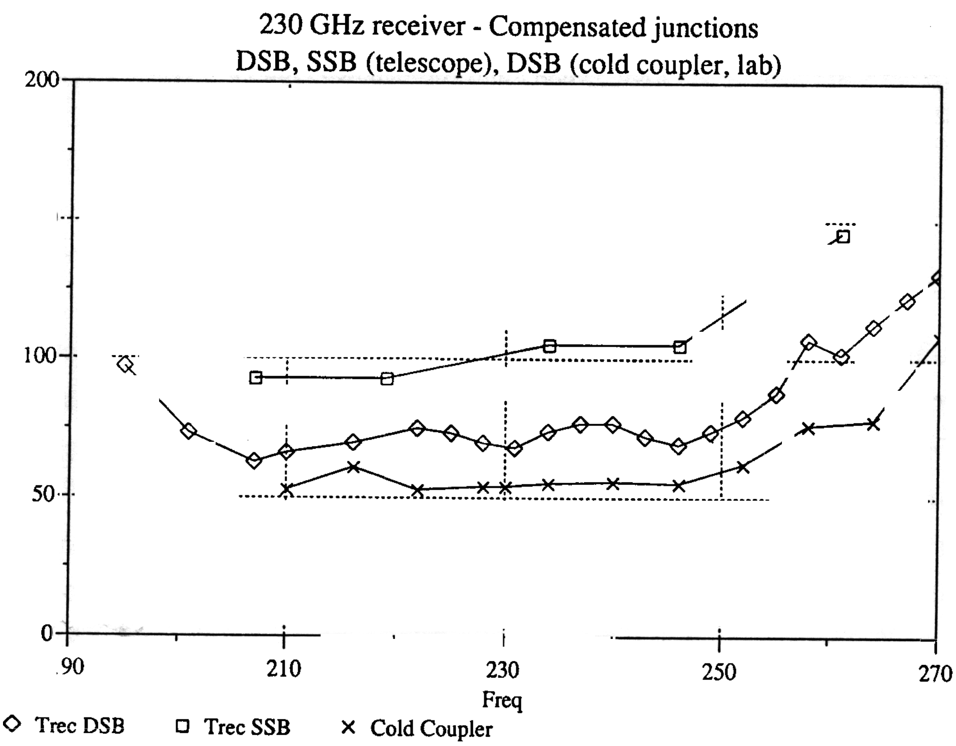



**Fig. 5.6:**
SSB and DSB performance of the new 230G1 receiver installed in December 1992. Note that the temperature scale is different from that in Fig.5.5 . Also shown are laboratory results obtained with the local oscillator injected through a cold waveguide coupler. This method of LO injection will be used for future receiver designs.

1992 on the 230G1 receiver position. At the time of writing, the stability of its output leaves to be desired, and this problem is under investigation. During the same technical session, the HEMT amplifiers were changed in both 230G1 and 230G2, giving a modest improvement in receiver performance.

*2mm SIS Receiver for Pico Veleta*

After the last Lead junction died, it was replaced with a Nb junction two weeks before Christmas. Noise performance is about 80K DSB at 145 GHz.

### 5.1.5 Laboratory Developments

*350 GHz Waveguide Receiver*

Good results were obtained with inductively compensated junctions: less than 100K DSB at 345 GHz. It was decided to build a receiver with such a junction in a "wet" cryostat, cooled with liquid nitrogen and helium, suitable for limited observing periods. That receiver is due to be tested at the telescope in March 1993.

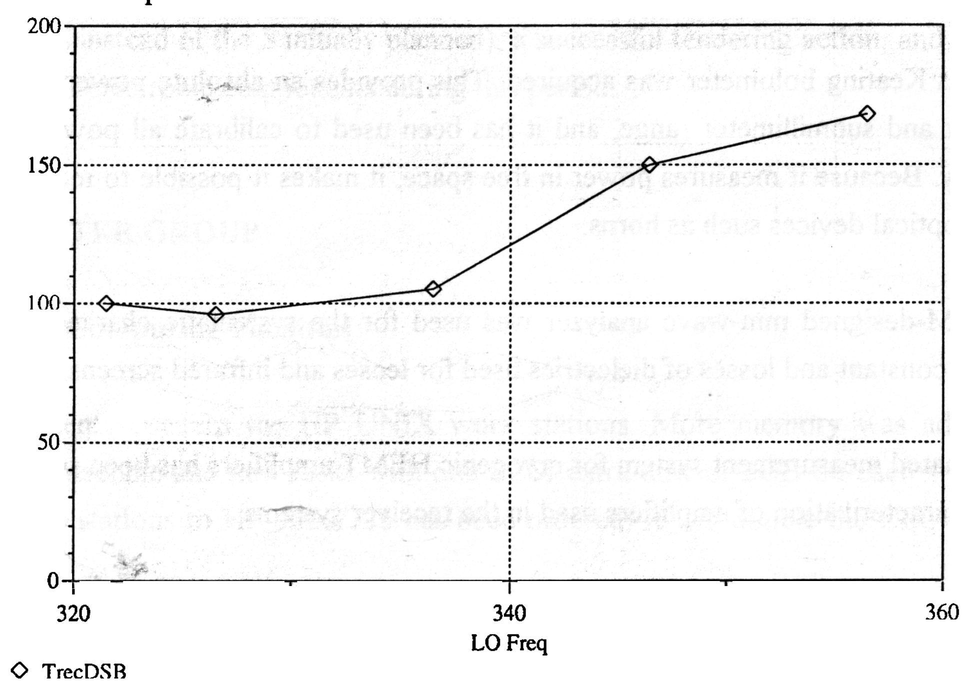



**Fig. 5.7:**
Laboratory results for the 345GHz SIS receiver using Niobium junctions with inductive compensation. This receiver is still being improved and is due to be tested on the 30m telescope in March 1993.

### *Antenna Test Range*

The antenna measurement system electronics and software were entirely redesigned with the help of a summer student. The new system is much more flexible and much faster than previously, allowing a 50x50 raster scan to be acquired in less than half an hour of unattended operation.

### *LO Injection Via Couplers*

Waveguide couplers, of the sidewall type, were successfully built and tested in laboratory receivers. The modest LO power requirements of SIS mixers allow the use of this method of LO injection up to the 350 GHz band. The coupler can be located on the cold stage, close to the mixer. It is inherently wideband and low-loss, has no adjustment, and is less susceptible to amplitude and phase modulations than either beamsplitter or diplexer injection. It will be used in all future receiver designs.

### *Other Developments*

A Thomas Keating bolometer was acquired. This provides an absolute power reference in the millimeter and submillimeter range, and it has been used to calibrate all power meters in the laboratory. Because it measures power in free space, it makes it possible to measure the losses of quasi-optical devices such as horns.

The IRAM-designed mm-wave analyzer was used for the systematic characterization of the dielectric constant and losses of dielectrics used for lenses and infrared screens.

An automated measurement system for cryogenic HEMT amplifiers has been set up and is used for the characterization of amplifiers used in the receiver systems.

## 5.2 BACKEND DEVELOPMENTS

The two correlator units sent to the 30m telescope have been progressively opened to all resolution modes. No help from Grenoble was necessary for this installation.

The Plateau de Bure Interferometer received five (of six) units in July. After a very short commissioning period, they were opened to radio astronomy. The sixth machine was kept a few months in Grenoble to support software and fine performance evaluation.

Both observatories have been intensively using the correlators in the second half of the year. The observers have obviously been satisfied with the resolution and stability of the obtained spectra. As a result, the useless and aging Berkeley correlators have been taken out of service.

The specific correlator chips suffer frequent failures. The manufacturer has been informed and is running an investigation on a batch of failed chips. However, the impact on observations is kept minimal by permanent check and prompt replacement of the failed devices.

The total costs for developing and building the new correlators were appreciably less than expected 3 years before. This was due to several favorable circumstances : the fact that a series was built (8 units instead of the 5 initially planned), a successful tendering action, and a general cost reduction for electronic components during this period.

## 5.3 COMPUTER GROUP

### 5.3.1 General Computing Facilities

Most improvements concern the HP UNIX work stations. More memory was added with 64 MBytes per machine and new disks with one SCSI extra disk of 2GB on each station. An upgrade of these stations to HP 9000/735 has been ordered. It will double the CPU power of those machines.

All reduction software developed by staff members from IRAM and GAG has been completely ported to UNIX/HP which becomes the main supported operating system for our distributed software.

In addition, a number of other facilities have been installed. They include MIDAS, the ESO image data analysis system, tools for the TEX typesetting system, name servers to access hosts directly with their domain names and access software to CD-ROMs, e.g. to the first issue of the IRAS Sky Survey Atlas.

For the Plateau de Bure, an HP710 work station has been added to speed up data processing and a large-screen X-terminal is now used by the operators both for reducing data and for monitoring operations on multiple terminal emulations connected via LAT to the real time VAX computer system.

The Ethernet cable at Bure has been extended to the tracks in prevision of the control of the receivers and the antennae with VME microprocessors under TCP/IP protocol.

### VME Control Units

A development of a full VME receiver control is in progress and a VME module for controlling the subreflectors has been designed and tested. This module will be installed in the antenna cabin with the receiver control system of which the microprocessor will be the link with the control real-time system, namely the micro-VAX BURE01.

For the new correlator, a specific Ethernet cable has been connected to BURE01. This extra link is the guarantee for a fast and reliable connection between the correlator VME microprocessors and BURE01.

The operational version of the Plateau de Bure cross-correlator software runs since this summer. Part of this software runs on 68030 micros, and the rest is executed on BURE01. Still some backend software needs CAMAC elements. They will be replaced by newer VME parts soon.

## 5.4 TECHNICAL GROUP

### General Developments

Only one important investment was made in 1992 for the purchase of a tool-grinder for tooling special grooves to fit mixers, triplers, or corrugated horns.

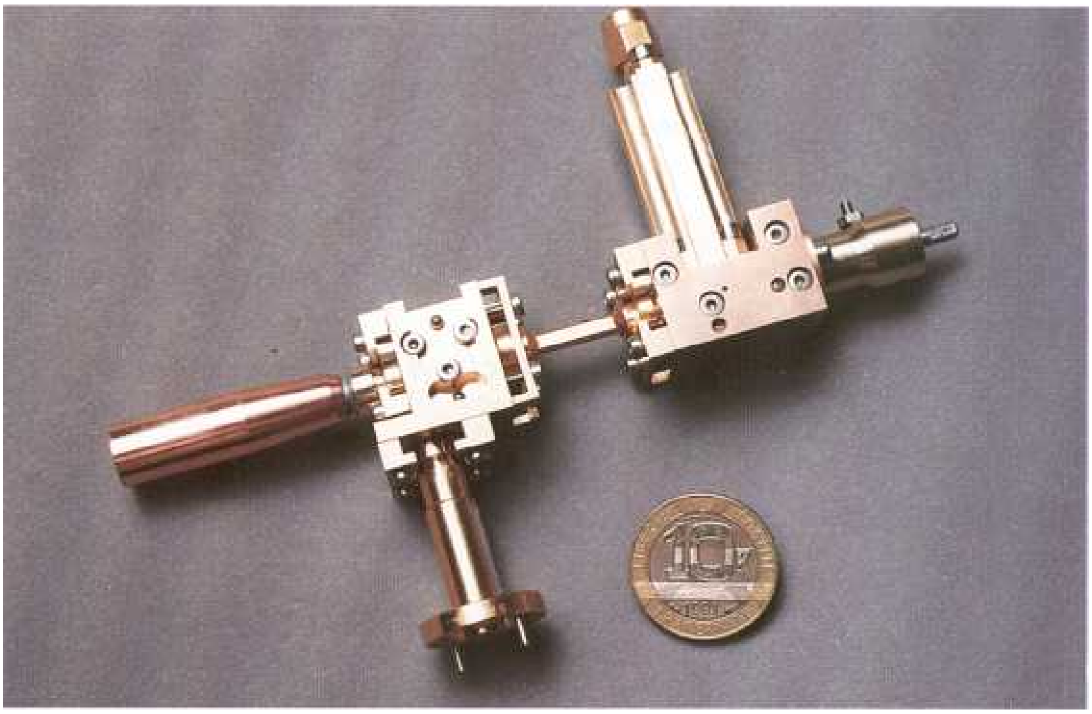


**Fig. 5.8:**
Set of 345GHz waveguide components, completely fabricated in the IRAM workshop. From left to right: corrugated horn, sidewall L.O. coupler, mixer with I.F. transformer.

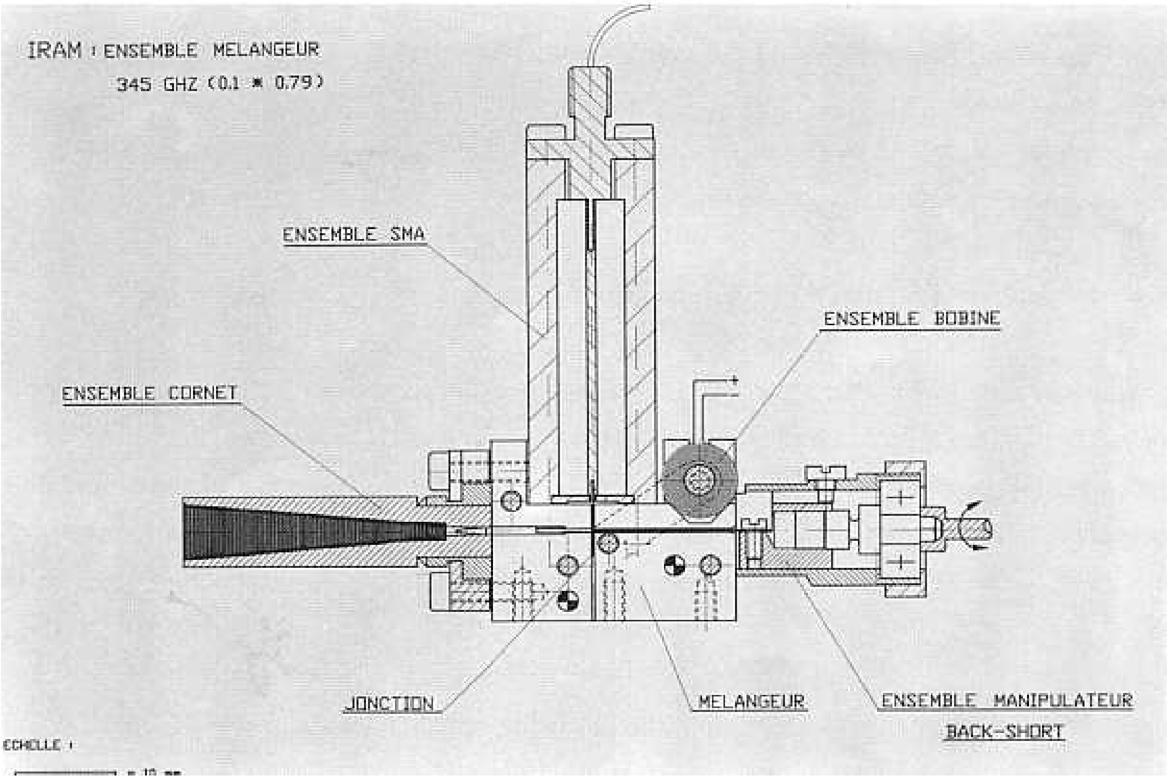



**Fig. 5.9:**
CAD drawing of the 345 GHz waveguide mixer.

More than 35 sets of RF and OL mixers, couplers, oscillators, triplers, etc. were fabricated in the mechanical workshop. Thanks to the close collaboration between precision mecanics and microwave-engineers, complete and perfectly adjusted sets could be delivered (see Fig. 5.8).

New techniques were developed for the parylen coating and the fabrication of loops for non-contacting backshorts.

The overall number of internal requests for manufacturing reached a total of 258, of which 38 were executed by external subcontractors.

### Drawing Office

In view of a possible extension of the interferometer on Plateau de Bure, the drawings and documents related to the mount of antenna 4 were updated. It was thus possible to realize technical improvements and to reduce the costs.

The use of the CAD system to produce drawings of components, subsystems and entire units has made good progress. An example of its application is shown in Fig. 5.9.

### Technical Support for Plateau de Bure

The technical group has been responsible for all mechanical aspects concerning the existing telescopes on Plateau de Bure and for keeping an up-dated set of the related documentation.

### Mount for Antenna 4 on Plateau de Bure

Since December 1990, the technical group has been responsible for the planning of the construction of the new antenna mount, for the monitoring and the control of various manufacturing activities in outside companies, as well as for the assembly of the mount at the observatory. The project advanced entirely on schedule and fully within the foreseen cost envelope. The entire mechanical structure, including the reflector, was completed in December 1992.

The planning at the end of 1992 foresees the following remaining activities:

| | |
|---|---|
| - remaining electrical installations for the reflector and the mount | January 1993 |
| - installation of receiver and full functional test | February 1993 |
| - first outdoors test, including first astronomical tests | March 1993 |

**Fig. 5.10:**
Assembly of the Antenna 4 telescope mount. On the left-hand side one arm of the fork is being mounted, on the right-hand side the elevation frame, which has a weight of 16 tons, is being integrated. The latter interfaces with the central hub of the reflector.

# 6. PERSONNEL AND FINANCES

In 1992, IRAM had a total of 108 employees. Of these, 95 were IRAM staff members, 8 were PhD students, post-docs or cooperants, 4 in Grenoble, 4 in Granada, and the remaining 5 persons had temporary contracts for the assembly of the 4th antenna on Plateau de Bure.

One of the staff positions in the SIS laboratory is jointly financed by the MPIfR and the MPI für Extraterrestrische Physik. The MPIfR also finances one of the post-doc positions in Spain.

IRAM's financial situation in 1992 and the budget provisions for 1993 are summarised in the following tables. Expenditures were higher than foreseen in the 1992 operations budget, but lower than foreseen in the investment budget.

The major items in the investment budget were : 1.2 MF for new laboratory equipment, and an 8.7 MF payment for the 4th antenna for the Plateau de Bure interferometer, as well as 0.5 MF for improvements in the existing IRAM antennas in Spain and France. Further investments were made in receivers and backends (1.5 MF), computers (1.8 MF), VLBI equipment (6.1 MF), administration and transport (0.1 MF), and infrastructure (0.2 MF). The planned extension of the SIS laboratory for the development of junctions for submm astronomy includes a NbN sputter system and a scanning electron beam microscope, to be financed by CNES, the MPIfR, the MPE and a donation from Advantest Corporation, Japan. Initial investments for this extension in 1991 were 0.8 MF. The planned extension for the Grenoble headquarters (2.3 MF) could not be started in 1992 due to delays in getting approval from the local authorities.

Income other than contributions from the IRAM partners was higher than foreseen due to income related to special projects (e.g. NbN sputter system, VLBI), or as a result of interest and capital gains.

The longstanding problem of the reimbursement of Spanish Value Added Tax (V.A.T.) payments which IRAM had claimed, has now partially been resolved. The tax office has reimbursed the V.A.T. since 1988, but the reimbursements for 1986 and 1987 are still pending, subject to the outcome of a court decision in Madrid.

A financial agreement was reached in June 1992 with the panel manufacturer for the Plateau de Bure antennas and IRAM's insurance company. The insurance company also compensated the costs of a snow damage incurred by one of the PdB antennas in 1991.

## BUDGET 1992

### Expenditure

| BUDGET HEADING | APPROVED BUDGET KFF | ACTUAL BUDGET KFF |
|---|---|---|
| Personnel | 33.947 | 34.501 |
| Operations | 14.772 | 15.941 |
| | 48.719 | 50.442 |
| Investments | 22.101 | 20.185 |
| Value Added Taxes | 4.224 | 4.224 |
| | 75.044 | 74.851 |

### Income

| BUDGET HEADING | APPROVED BUDGET KFF | ACTUAL BUDGET KFF |
|---|---|---|
| Contribution CNRS | 27.156 | 27.156 |
| Contribution MPG | 27.156 | 27.156 |
| Contribution IGN | 3.466 | 3.466 |
| Other Income | 13.042 | 28.492 |
| Contribution CNRS for Value Added Taxes | 4.224 | 4.224 |
| | 75.044 | 90.494 |

## BUDGET PREVISIONS 1993 (KFF)

### Expenditure

| BUDGET HEADING | APPROVED BUDGET |
|---|---|
| Personnel | 35.630 |
| Operations | 15.770 |
| | 51.400 |
| Investments | 11.942 |
| Value Added Taxes | 4.432 |
| | 67.774 |

### Income

| BUDGET HEADING | APPROVED BUDGET |
|---|---|
| Contribution CNRS | 28.651 |
| Contribution MPG | 28.651 |
| Contribution IGN | 3.658 |
| Other Income | 2.382 |
| Contribution CNRS for Value Added Taxes | 4.432 |
| | 67.774 |

| WEEK | DATE | IDENT | TITLE | Freq. (GHz) | PEOPLE |
|---|---|---|---|---|---|
| 02/03 | Jan 7 - 21 | 287.91 | A molecular study of detached envelopes | | Tejero, Bujarrabal, Cernicharo, Fuente |
| | | 267.91 | 2H in circumstellar envelopes: a tracer of acetylene and dust condensation | 87, 174, 262 | Tejero, Cernicharo, Omont, Maillard |
| | | 262.91 | A study of water vapor emission toward molecular clouds and evolved stars at 183, 325GHz | | |
| | | 206.91 | Absolute flux density scale at mm-wavelengths (30m MRT antenna parameters) | Continuum | Greve, Steppe |
| | | 220.91 | A study of the 28 SiO maser emission in VYCMa | 258, 260 | Cernicharo, Bujarrabal, Santaren |
| | | 258.91 | Synthesis of SiO in stellar winds from young stars | 86,130,217 | Martin-Pintado, Bachiller, Fuente |
| | | 199.91 | Compact clouds in the intergalactic medium | 115, 230 | Reuter, Pohl, Lesch, Sievers |
| | | 251.91 | Feeding the monster : molecular infall or outflow toward Sgr A* | 115,230,110,220 | Wilson, Pauls, Rudolph, Marr |
| 04/05 | Jan 21 - Feb 4 | 199.91 | Compact clouds in the intergalactic medium | 115, 230 | Reuter, Pohl, Lesch, Sievers |
| | | 246.91 | Deuterium in galactic nuclei | 144, 152 | Henkel, Walmsley, Millar, Schilke, Hüttemeister, Mauersberger |
| | | 213.91 | G45.47+ 0.05 : a collapsing molecular clump | 97,146,244,96... | Cesaroni, Walmsley, Churchwell, Hofner |
| | | 178.91 | A search for interstellar isocyanoacetylene | 89 | Walmsley, Guarniem, Winnewisser, Wouterloot, Schilke |
| | | 183.91 | The cold and cool ISM in nearby galaxies | 115, 230 | Brouillet, Bomans, Brinks, Puche, Sage, Westpfhal |
| | | 217.91 | Obs. of HCN(J=1.0) in Maffei 2. Comp. mapping for emission at low spatial freq. for PdB | 88,131,265 | Rieu, Viallefond, Combes, Jackson, Lequeux, Truong-Bach |
| | | 241.91 | A search for CN in oxygen-rich circumstellar envelopes | 226 | Olofsson, Lindqvist, Winnberg, Nyman, Rieu |
| | | 209.91 | The molecular ISM in He 2-10 | | Wu, Eckart, Drapatz, Rothermel |
| | | 231.91 | A molecular cloud enshrouding a black hole ? | 72,87,109,262 | Mirabel, Wink, Morris |
| | | 235.91 | The very small scale struct. of mol. clouds. High angular resolution iso. CO mapping of L145 | 98,109,220 | Zimmermann, Stutzki |
| 06/07 | Feb 4 - Feb 18 | 209.91 | The molecular ISM in He 2-10 | | Wu, Eckart, Drapatz, Rothermel |
| | | 231.91 | A molecular cloud enshrouding a black hole ? | 72,87,109,262 | Mirabel, Wink, Morris |
| | | 235.91 | The very small scale struct. of mol. clouds. High angular resolution iso. CO mapping of L145 | 98,109,220 | Zimmermann, Stutzki |
| | | 180.91 | The atmosphere of IO | 221,146,143,224 | Lellouch, Belton, de Pater, Gulkis, Paubert, Encrenaz |
| | | 288.91 | The scale height of the gas in edge-on galaxies | 115, 230 | Garcia-Burillo, Guélin, Cernicharo |
| | | 206.91 | Absolute flux density scale at mm-wavelengths (30m MRT antenna parameters) | Continuum | Greve, Steppe |
| | | 286.91 | Deepening the study of molecular cloiuds physics in Messier 51 | 110,220,345 | Garcia-Burillo, Guélin, Cernicharo |
| | | 212.91 | Dense molecular gas in a primeval starburst | 80,104,107,140 | Solomon, Radford, Downes |
| | | 244.91 | High velocity ionized gas near young high-mass stars | 92,99,115,135 | Jaffe, Martin-Pintado |
| | | 2.92 | Search for H20 and 02 in the Z=2.286 object | 112, 169,228 | Combes, Casoli, Encrenaz, Gerin, Laurent, Pagani |
| 08/09 | Feb 18 - Mar 3 | | TECHNICAL TIME - BOLOMETER TIME (Programs 300 - 306.91) | | |
| 10/11 | Mar 3 - Mar 17 | 256.91 | Cold dust in spiral galaxies | Bolometer | Chini, Krügel, Kreysa |
| | | 275.91 | Wide-band intrinsic spectra of the cores of extended quasars | Bolometer | Steppe, Krishna |
| | | 222.91 | Dusty disks around young stars in the Pleiades and alpha Persei | Bolometer | Zinnecker |
| | | 299.91 | Protostars in the Orion CS cores | Bolometer | Zinnecker, Yorke |
| | | 248.91 | Small scale anisotropy of the cosmic microwave background at 230 GHz | Bolometer | Kreysa, Chini, Bierman |
| | | 254.91 | | Bolometer | Kreysa, Bierman, Chini |

| WEEK | DATE | IDENT | TITLE | Freq. (GHz) | PEOPLE |
|---|---|---|---|---|---|
| | | 269.91 | The pulsar supernova connection : deep cont. survey of recent nearby supernova at 1.3mı | Bolometer | Tuffs, Chini |
| | | 236.91 | Interstellar dust in a protogalaxy | Bolometer | Solomon, Radford, Greve, Downes |
| | | 231.91 | A molecular cloud enshrouding a black hole ? | 72,87,109,262 | Mirabel, Wink, Morris |
| | | 234.91 | Spatial structure of candidate protostellar objects in RHO OPHIUCHI | Bolometer | André, Montmerle, Cabrit |
| | | 264.91 | Mapping the circumstellar dust material around young luminous stars of low to intermed. r | Bolometer | Cabrit, Montmerle, André, Ménard |
| | | 283.91 | Low-mass star forming cores : dust continuum | Bolometer | Fiebig, Güsten |
| | | 265.91 | Are massive circumstellar structures powering molecular outflows ? | 230 | André, Cabrit, Therebey, Lada |
| | | 221.91 | Mm-to-cm spectrum of 6 radio-bright RS CVn binaries | Bolometer | Guedel, Fuerst, Skinner, Linsky, Brown |
| 12/13 | Mar 17 - Mar 31 | 221.91 | Mm-to-cm spectrum of 6 radio-bright RS CVn binaries | Bolometer | Guedel, Fuerst, Skinner, Linsky, Brown |
| | | 236.91 | Interstellar dust in a protogalaxy | Bolometer | Solomon, Radford, Greve, Downes |
| | | 198.91 | Bolometer service observations of the luminous type 1 Seyfert 1434+590 | | Barvainis, Coleman, Antonucci |
| | | 52.92 | The structure of the dense molecular gas in the nuclei of NGC 1068 and NGC 253 | 345 | Tacconi, Genzel, Harris |
| | | 32.92 | A search for HCN "vibrational" maser transitions in carbon rich stars | 345 | Cernicharo, Gonzalez-Alfonso, Tejero, Lucas |
| | | 9.92 | 30m antenna efficiency and flux densities at 350 GHz | 345 | Greve, Steppe |
| | | 51.92 | Warm outflows in low-mass protostars | 345 | Anderson, Schuster, Genzel, Harris, Tacconi |
| | | 47.92 | A deep search for the MgH radical | 345 | Guélin, Cernicharo, Tejero, Kahane, Lucas, Omont |
| | | 86.92 | (3-2) CO and 12 CO spectra of an ordinary edge on galaxy (NGC 891) | 345 | Rothermel, Greve |
| | | 40.92 | Search for the (CII) 158 um line at very high redshifts | 345 | Lequeux, Boissé, Encrenaz, Guélin, Puget, Rothermel |
| 14/15 | Mar 31 - Apr 14 | 95.92 | CO in a complete sample of distant ultraluminous galaxies | | Downes, Solomon, Gao, Radford |
| | | 18.92 | Minor compounds in the stratospheres of Saturn, Uranus, Neptune | 88,159,115,269 | Lellouch, Rosenqvist, Romani, Paubert |
| | | 180.91 | The atmosphere of IO | 221,146,143,224 | Lellouch, Belton, de Pater, Gulkis, Paubert, Encrenaz |
| | | 2.92 | Search for H2O and O2 in the Z=2.286 object | 112,169,228 | Combes, Casoli, Encrenaz, Gerin, Laurent, Pagani |
| | | 65.92 | Search for nitric oxide in TMC1 | 87,93,113,250 | Gerin, Viala, Talbi |
| | | 245.91 | Molecular condensations in the Dumbbell and the Helix | 115, 230 | Huggins, Bachiller, Forveille |
| | | 296.91 | Search for the HCCCO carbon chain radical in astronomical sources | 90,99,108,226 | Guélin, Thaddeus |
| | | 58.92 | Velocity shifts in L1204: core disruption by the action of bipolar outflows | 115,230,98,147 | Tafalla, Bachiller |
| | | 208.91 | Ring galaxies and Hoag's type objects | | Casoli, Horellou, Dupraz, Combes |
| | | 46.92 | Measurement of the 26 Al/27 Al isotopic ratio in IRC+10216 | 218,221,234 | Guélin, Cernicharo, Tejero, Kahane, Lucas, Omont |
| | | 286.91 | Deepening the study of molecular cloiuds physics in Messier 51 | 110,220,345 | Garcia-Burillo, Guélin, Cernicharo |
| | | 206.91 | Absolute flux density scale at mm-wavelengths (30m MRT antenna parameters) | Continuum | Greve, Steppe |
| 16/17 | Apr 14 - Apr 28 | 205.91 | Search for LiH primordial lines | 130, 233 | De Bernardis, Dubrovich, Melchiorri, Encrenaz, Signore |
| | | 180.91 | The atmosphere of IO | 221,146,143,224 | Lellouch, Belton, de Pater, Gulkis, Paubert, Encrenaz |
| | | 94.92 | C18O and high mass stars formation in ultraluminous galaxies | | Radford, Solomon, Downes |
| | | 96.92 | 13 CO in ultraluminous galaxies | | Radford, Solomon, Downes |
| | | 261.91 | Search for HCP on Saturn, Uranus and Neptune | 119,159,239,319 | Encrenaz, Coustenis, Lellouch, Crovisier, Bockelée-Morvan |
| | | 18.92 | Minor compounds in the stratospheres of Saturn, Uranus, Neptune | 88,115,159,269 | Lellouch, Rosenqvist, Romani, Paubert |

| WEEK | DATE | IDENT | TITLE | Freq. (GHz) | PEOPLE |
|---|---|---|---|---|---|
| | | 230.91 | The chemistry of the IC 63 nebula | 104,130,168,218 | Van Dishoeck, Jansen, Black |
| | | 5.92 | CH3CN towards ultra compact HII regions | 110,147,220 | Cesaroni, Walmsley, Olmi, Churchwell, Hofner |
| | | 271.91 | Correlation between gas density and infrared colors | 98,146,115,220 | Boulanger, Falgarone |
| | | 297.91 | Calibrating the CO Tully-Fisher relation in Hercules | 111 | Kazès, Dickey |
| 18/19 | Apr 28 - May 12 | 187.91 | Strong CO in an isolated galaxy | 110,115,220,230 | Braine, Combes, Shore |
| | | 273.91 | Searches for interstellar MgOH and CaOH | 140,160,148,177 | Ziurys, Barclay, Anderson, Wilson |
| | | 70.92 | Confirming the detection of true low-mass protostars | 97,146,230 | Güsten, Fiebig |
| | | 7.92 | A search for intergalactic molecular clouds : are dwarf galaxies still forming | 115, 230 | Brouillet, Baudry, Henkel |
| | | 25.92 | Dense and shocked gas in the inner part of M82 | 88, 90 | Brouillet, Schilke, Pineau des Forêts, Baudry |
| | | 20.92 | NGC 3187 : Little FIR, little blue light, but lots of CO ? | 114, 229 | Braine |
| | | 98.92 | The transition of atomic to molecular gas in MCLD 126.6+24.5 | 88,90,219,177 | Heithausen, Corneliussen |
| | | 206.91 | Absolute flux density scale at mm-wavelengths (30m MRT antenna parameters) | Continuum | Greve, Steppe |
| 20/21 | May 12 - May 26 | 29.92 | CO rotation curves in selected edge-on galaxies | 115, 230 | Wielebinski, Ott, Reuter, Krause, Grewing |
| | | 42.92 | Tidally induced spiral arm pattern in the dust rich galaxy NGC 3627 | 115, 230 | Reuter, Pohl, Lesch, Wielebinski |
| | | 63.92 | Search for H2CO and H2O2 in the Martian atmosphere | 115,150,225,250 | Marten, Rosenqvist, Muller |
| | | 298.91 | Observations of HC3N on TITAN | 145, 218 | Bézard, Marten, Paubert |
| | | 49.92 | CO emission and absorption towards extragalactic sources | 115, 230 | Thum, Steppe, Downes |
| | | 206.91 | Absolute flux density scale at mm-wavelengths (30m MRT antenna parameters) | Continuum | Greve, Steppe |
| | May 23 - May 29 | | **7mmVLBI** | | |
| 22/23 | May 26 - Jun 9 | | **HOLOGRAPHY** | | IRAM Staff |
| | | 31.92 | C34S and C18O in preastral cloud cores and protostellar objects in the Rho Oph clouds | 96,144,241,109 | Mauersberger, Wilson, Mezger |
| | | 57.92 | A CO survey of Seyfert 1 and Seyfert 2 galaxies | 115, 230 | Steppe |
| | | 38.92 | Circumnuclear molecular gas in Seyfert galaxies | 114, 229 | Planesas, Colina, Martin-Pintado, Diaz |
| | | 39.92 | Molecular gas in three selected nuclear starburst galaxies | 115,114,230,229 | Planesas, Colina, Diaz |
| | | 33.92 | The molecular outflows of the youngest stellar objects | 115, 230 | Bachiller, Juan |
| | | 34.92 | Molecular bow-shocks in bipolar outflows | 86,130,217 | Bachiller, Martin-Pintado, Fuente, Juan |
| 24/25 | Jun 9 - Jun 23 | 206.91 | Absolute flux density scale at mm-wavelengths (30m MRT antenna parameters) | Continuum | Greve, Steppe |
| | | 4.92 | Mm-Cm investigations of the continuum emission from BL Lacs and OWs | 90, 15 | Robson, Hughes, Litchfield, Valtoaoja, Gear, Steppe |
| | | 76.92 | Circumstellar CO around bright oxygen rich semi regulars | 230 | Jura, Kahane |
| | | 77.92 | Search for circumstellar molecules around the red rectangle | 88,90,136,244 | Jura, Kahane |
| | | 14.92 | A search for extragalactic HNC | 90 | Henkel, Hüttemeister, Mauersberger, Brouillet, Wiklind |
| | | 11.92 | The chemistry of S-type stars | 86,88...265 | Bujarrabal, Omont, Fuente, Alcolea |
| | | 12.92 | The discrimination between O- and C-rich circumstellar envelopes from molecular observc | 97,146,265,217 | Bujarrabal, Omont, Fuente, Alcolea |
| 26/27 | Jun 23 - Jul 7 | 16.92 | | 233,219,109 | Fuente, Cernicharo, Garcia-Burillo, Tejero |

| WEEK | DATE | IDENT | TITLE | Freq. (GHz) | PEOPLE |
|---|---|---|---|---|---|
| | | 73.92 | A molecular study of peculiar C-rich envelopes | 90,136,236,97 | Tejero, Cernicharo, Omont, Maillard |
| | | 48.92 | CO photodissociation at the edges of the IRC+10216 envelope | 110,115,220,230 | Guélin, Cernicharo, Tejero, Kahane, Lucas, Omont |
| | | 26.92 | A molecular study of detached envelopes | 86, 265 | Tejero, Bujarrabal, Cernicharo, Fuente |
| | | 93.92 | Multiline survey of molecular gas in ultraluminous galaxies | | Radford, Solomon, Downes |
| | | 92.92 | Evolution of star-forming clumps in the Taurus molecular complex | 96,144,219,244 | Le Floch, Lazareff, Cernicharo |
| 28/29 | Jul 7 - Jul 21 | | **3mmVLBI** | | IRAM Staff |
| | | 57.92 | A CO survey of Seyfert 1 and Seyfert 2 galaxies | 115, 230 | Steppe |
| | | 82.92 | Molecular line emission from stellar disks | 115,230,98,110 | Chini, Wilson, Reipurth, Krügel |
| | | 27.92 | Study of a cold collapsing cloud | | Krügel, Chini |
| | | 41.92 | Physical conditions in ionized stellar winds | 92,147,231 | Martin-Pintado, Planesas, Gomez-Gonzalez |
| | | 65.92 | Search for nitric oxide in TMC1 | 87,93,108,250 | Gerin, Viala, Talbi |
| | | 87.92 | The small scale structure of a GMC | 97,146,244,219 | Dutrey, Bachiller, Castets, Duvert, Walmsley |
| 30/31 | Jul 21 - Aug 4 | 89.92 | Nature of the remarkable young stellar object VLA 1623 | 96,140,211,240 | André, Wootten, Despois |
| | | 60.92 | CO map of NGC 628 center | 115, 230 | Combes, Casoli, Viallefond |
| | | 64.92 | On the nature of remote ultraluminous objects | 168,252,144,224 | Wiklind, Combes |
| | | 68.92 | Dense gas in absorption line systems towards quasars ? | 99,106,151,226 | Wiklind, Combes |
| | | 81.92 | C34S and C18O in preastral cloud cores and protostellar objects in the Rho Oph clouds | 96,144,241,109 | Mauersberger, Wilson, Mezger |
| | | 57.92 | A CO survey of Seyfert 1 and Seyfert 2 galaxies | 115, 230 | Steppe |
| | | 33.92 | The molecular outflows of the youngest stellar objects | 115, 230 | Bachiller, Juan |
| | | 34.92 | Molecular bow-shocks in bipolar outflows | 86,130,217 | Bachiller, Martin-Pintado, Fuente, Juan |
| 32/33 | Aug 4 - Aug 18 | 67.92 | Distribution and kinematics of molecular clouds in elliptical galaxies | 113,115,226,230 | Wiklind, Combes, Lees, Henkel, Rupen |
| | | 72.92 | Search for molecular gas in the central regions of M31 | 115, 230 | Lequeux, Allen |
| | | 25.92 | Dense and schocked gas in the inner part of M82 | 88, 90 | Brouillet, Schilke, Pineau des Forêts, Baudry |
| | | 23.92 | Molecular gas in faint dwarf galaxies | 115, 230 | Lo, Schilke, Adler |
| | | 24.92 | Sulphur bearing molecules as a shock tracers ? | 100,107,138,228 | Schilke, Walmsley, Fower, Pineau des Forêts |
| 34/35 | Aug 18 - Sep 1 | | **TECHNICAL TIME SUB REFLECTOR + 3mmMX ; 3+1mm RX TEST** | | |
| | | | **RX + KEY PROGRAM TEST** | | Dutrey, Lefloch |
| | | 137.92 | A search for vinylidene (H2CC) in TMC1 and IRC+10216 | | Cernicharo, Guélin, Walmsley |
| | | 174.92 | Search for the HCCS radical in interstellar clouds | 88 | Guélin, Thaddeus, Cernicharo |
| | | 56.92 | CO observations of a star forming molecular cloud at large galactocentric distance | 110,115,220,230 | Brand, Wouterloot |
| | | 37.92 | Density wave induced star formation in the arms of NGC 3631 : CO observations | 114, 229 | Knapen, Van der Kruit, Beckman, Cepa |
| 36/37 | Sep 1 - Sep 15 | 135.92 | Small scale structure in BOK globules | 98,147,219 | Launhardt, Lemme, Pfau, Martin, Kömpe |
| | | 49.92 | CO emission and absorption towards strong extragalactic sources | | Thum, Steppe, Downes |
| | | 142.92 | A detailed study of an extremely quiescent core : L1498 | 96,109,146,244 | Lemme, Wilson, Walmsley |

| WEEK | DATE | IDENT | TITLE | Freq. (GHz) | PEOPLE |
|---|---|---|---|---|---|
| | | 110.92 | Very high velocity molecular gas near Sgr A* | 115, 230 | Wilson, Lemme, Mauersberger,Marr, Rudolph, Pauls |
| | | 157.92 | Different type of shocks in high velocity molecular outflows ? | 90,168,244 | Martin-Pintado, Fuente, Bachiller |
| | | 206.91 | Absolute flux density scale at mm-wavelengths (30m MRT antenna parameters) | Continuum | Greve, Steppe |
| | | 10.92 | Hyperfine sublevel lines in Perseus A (3C 84) | 92, 247 | Greve, Morris, Tuffs, Keenan |
| 38/39 | Sep 15 - Oct 1 | | | | |
| | | 131.91 | Is there an intrinsic difference between Seyfert 1 and Seyfert 2 galaxies ? | 111,115,223,230 | Steppe |
| | | 159.91 | Is a galaxy's HCN luminosity a good indicator of its star forming rate ? | | Solomon, Radford, Downes |
| | | 160.91 | L1287-RN01B : A unique FUOri object associated with a molecular outflow | 86,130,144,230 | Guilloteau, Lazareff, Le Floch, Staude |
| | | 164.91 | A search for signs of ongoing star formation in the dense cores of Taurus.. | 115, 230 | Le Floch, Cernicharo, Lazareff |
| 40/41 | Sep 29 - Oct 13 | 129.92 | The disturbed central region and disk halo interface of NGC 4631 | 110,115,230 | Golla, Wielebinski, Krause |
| | | 127.92 | Kinematics and dynamics of the galaxy NGC 7331 | 115, 230 | Ott, Krause, Von-Linden, Wielebinski |
| | | 158.92 | CO mapping of the nonspherical outflow in the envelope of the carbon star TX | 115, 230 | Kahane, Hekkert, Forveille, Audinos |
| | | 151.92 | Where are the H2 deficient galaxies in Coma ? | 111,113,225,226 | Casoli, Boissé, Gavazzi, Combes, Kazès, Dickey |
| | | 103.92 | The "shocking" truth about the planetary nebula VV 503 | 85, 267 | Neri, Hopfensitz, Kreysing, Garcia-Burillo, Grewing |
| | | 149.92 | CO in HI deficient galaxies : the NGC 4278's group | 115, 230 | Gerin, Casoli, Combes |
| | | 153.92 | CO in Seyfert ring galaxies | 109,218,220 | Horellou, Casoli, Combes, Dupraz |
| 42/43 | Oct 13 - Oct 27 | 149.92 | CO in HI deficient galaxies : the NGC 4278's group | 115, 230 | Gerin, Casoli, Combes |
| | | 153.92 | CO in Seyfert ring galaxies | 109,218,220 | Horellou, Casoli, Combes, Dupraz |
| | | 112.92 | The column density of CO toward Zeta Ophiuchi | 115, 230 | Wilson, Mauersberger, Lemme, Dahmen |
| | | 134.92 | CO isotopes in the Rho Oph cloud | 112, 224 | Mauersberger, Sievers, Wilson, Mezger |
| | | 104.92 | The carbon isotope ratio in extragalctic starburst nuclei | 108 | Henkel, Mauersberger, Wilson, Hüttemeister |
| | | 170.92 | Dynamics of radiative globule implosion | 97,110,146,230 | Le Floch, Lazareff |
| | | 163.92 | A search for counterrotating molecular gas in lenticular galaxies | 115, 230 | Wiklind, Henkel, Sage |
| | | 136.92 | Emission lines from molecular disks | 219,224 | Hessman, Beckwith |
| | | 114.92 | Do stars form in cooling flow gas ? | 106,113,212,226 | Braine, Dupraz |
| 44/45 | Oct 27 - Nov 10 | 105.92 | CO observations of detached envelopes around M stars | 115, 230 | Loup, Waters, Zijlstra, De Jong, Nyman |
| | | 164.92 | CO observations of the galaxy NGC 4501 | 114, 228 | Bosma, Van Gorkom, Athanassoula |
| | | 132.92 | Deficiency of CO emission in circumstellar shells of M and OH/IR stars | 115, 230 | Loup, Forveille, Omont, Nyman, De Jong, Barnbaum |
| | | 206.91 | Absolute flux density scale at mm-wavelengths (30m MRT antenna parameters) | Continuum | Greve, Steppe |
| | | 144.92 | Physical conditions of molecular disks around FU Ori stars | 98,138,219,135 | Fiebig, Duschl, Tschamuter |
| 46/47 | Nov 10 - Nov 24 | 137.92 | A search for vinylidene (H2CC) in TMC1 and IRC+10216 | | Cernicharo, Guélin, Walmsley |
| | | 268.92 | Search for molecular lines in Comet Swift-Tutle 1992t | 88,145,168,265 | Colom, Crovisier, Bockelée-Morvan,Jorda, Despois,Paubert |
| | | 128.92 | A multiline study of SiO masers in evolved stars | 86,129,172,258 | Cernicharo, Bujarrabal, Santaren |
| | | 173.92 | Calibration of the spectral survey made in IRC+10216 with the 30m telescope | 89,114,131,265 | Guélin, Cernicharo, Kahane |

| WEEK | DATE | IDENT | TITLE | Freq. (GHz) | PEOPLE |
|---|---|---|---|---|---|
| | | 169.92 | Excitation and abundance of SO and SO2 in circumstellar envelopes | 99,160,219,254 | Lucas, Omont, Morris |
| | | 148.92 | Molecular oxygen in the z=2.3 galaxy ? | 112,129,236 | Casoli, Combes, Encrenaz, Gerin, Laurent, Pagani |
| | | 177.92 | CO and CI in primeval galaxies | 80,140,245 | Solomon, Radford, Downes |
| | | 181.92 | C18O and high mass stars formation in ultraluminous galaxies | 105,107,210,219 | Radford, Solomon, Downes |
| 48/49 | Nov 24 - Dec 8 | 125.92 | Dusty disks around the TTauri stars in the Orion OB 1 association | Bolometer | Zinnecker, Thum |
| | | 130.92 | Mapping the circumstellar dust material around young luminous stars of low to interm. ma: | Bolometer | André, Cabrit, Montmerle, Ménard |
| | | 179.92 | Dust in primeval galaxies | Bolometer | Solomon, Radford, Downes |
| | | 161.92 | Bolometer survey of Myers cores with no embedded sources | Bolometer | André, Ward-Thompson, Hills |
| | | 117.92 | Are there 2 populations of Bllacs? A comparison of an x-ray and radio selected sample | Bolometer | Gear |
| | | 166.92 | The evolution of mass in circumstellar disks | Bolometer | Beckwith, Sargent |
| | | 123.92 | The spectral energy distribution of Vega-like stars | Bolometer | Butner, Walker, Beckwith, Lada |
| | | 160.92 | Circumstellar dust masses of the youngest stellar objects in Bok globule cores | Bolometer | Henning, Launhardt, Thamm, Pfau, Lemme |
| | | 202.92 | Bolometer observations of Asteroid 4179 Toutatis at 250 GHz | Bolometer | Altenhoff, Thum, Wielebinski |
| 50/51 | Dec 8 - Dec 22 | 171.92 | Search for new pointing sources | Bolometer | Steppe, Thum, Greve |
| | | 202.92 | Bolometer observations of Asteroid 4179 Toutatis at 250 GHz | Bolometer | Altenhoff, Thum, Wielebinski |
| | | 159.92 | The brightness temperature of Mars as function of its longitude | Bolometer | Altenhoff |
| | | 109.92 | Bolometer service observations of the luminous type 1 Seyfert 1434+590 | Bolometer | Barvainis, Coleman, Antonucci |
| | | 165.92 | Continuum observations of Be-Stars at 250 GHz | Bolometer | Altenhoff, Thum, Wendker |
| | | K003.92 | **KEY PROJECT : Small scale structure of pre-star forming clouds** | | Falgarone et al |
| | | 185.92 | Search for H2CO and H2O2 in the Martian's atmosphere | 225,251,115 | Marten, Rosenqvist, Muller |
| 52/53 | Dec 22 - Jan 5 | 119.92 | The effects of density on the star formation efficiency | 97,244,96,241 | Lada, Evans, Falgarone |
| | | 121.92 | A detailed study of Mon R2 | 86, 225 | Evans, Choi, Zhou, Mangum, Tafalla, Bachiller |
| | | 37.92 | Density wave induced star formation in the arms of NGC 3631 : CO observations | 114, 229 | Planesas, Colina, Martin-Pintado, Diaz |
| | | 133.92 | Large scale triggering of star formation in the arms of NGC 3631 CO observations | 230 | Knapen, Van der Kruit, Beckman, Cepa |
| | | 172.92 | Observations of HC3N and search for CH3CN on Titan | 145,147,218,220 | Bezard, Marten, Paubert |
| | | 126.92 | Mars' middle atmosphere dynamics from CO lines | 115,220,230 | Lellouch, Goldstein, Bougher, Rosenqvist, Paubert |
| | | 141.92 | Mapping of HDO on Mars and search for minor species (NO, SO, ClO) | 115,143,219,250 | Encrenaz, Lellouch, Gulkis, Paubert |
| | | 274.92 | Observations of 3C 273 at mm wavelengths as part of a multifrequency campaign | 90, 210 | Staubert, Steppe |
| | | 206.92 | Is the ratio CO(2-1)/(1-0) 2 a local phenomenon in NGC 1569 ? | | Greve, Becker, Johansson, Prada, McKeith |

| Project | Conf. | Title | Authors | Molecules | Object | Type |
|---|---|---|---|---|---|---|
| A047 | BC | HCN in Maffei 2 | Nguyen-Q-Rieu J.Lequeux F.Casoli F.Combes M.Gérin J.Jackson F.Viallefond Truong-Bach | HCN | Maffei-2 | Gal |
| A056 | CD | Morphology and Kinematics of Circumstellar Disks around Outflow sources | S.Cabrit C.Bertout P.André A.Baudry D.Despois S.Guilloteau | $C^{18}O$ | B335 | YSO |
| B005 | B1,B3 C1,C3 | AFGL 2343 evolving to a non spherical planetary nebula | N.Doll R.Neri M.Grewing | CO | AFGL 2343 | CSE |
| B008 | BC or CD | Dense and Schocked Gas in the inner part of M 82 | P.Schilke N.Brouillet G.Pineau-des-Forêts A.Baudry | HNC | M 82 (SW) | Gal |
| B009 | BC or CD | Dense and Schocked Gas in the inner part of M 82 | P.Schilke N.Brouillet G.Pineau-des-Forêts A.Baudry | HCN | M 82 (NE) | Gal |
| B010 | BC or CD | Dense and Schocked Gas in the inner part of M 82 | P.Schilke N.Brouillet G.Pineau-des-Forêts A.Baudry | HNC | M 82 (NE) | Gal |
| B025 | CD | What is the threshold of self-similar hierarchy in cold molecular gas | E.Falgarone F.Boulanger J.L.Puget | CO | Perseus | Mol |
| B026 | BC | SiS and $HC_5N$ in IRC+10216 | R.Lucas M.Guélin C.Kahane J.Cernicharo | SiS $HC_5N$ | IRC+10216 | CSE |
| B027 | CD | Chemical Processes and their localisation in CRL 2688 | R.Lucas A.Omont C.Kahane | SiS $HC_5N$ | CRL 2688 | CSE |
| B028 | C1,C2 D1 | The spatial extent of $SO_2$ in O-rich circumstellar envelopes | R.Lucas A.Omont M.Morris | $SO_2$ | IRC+10011, IRC+10420 OH26.5+0.6 | CSE |
| B035 | BC | Distant merging galaxies | S.Radford D.Downes P.Solomon | CO | 1056+24 | Gal |
| B042 | BC | Survival of Dusty Disks in Pre-MS multiple systems | M.Simon S.Guilloteau | Cont. | UZ Tau CG Tau | YSO |
| B046 | C2 (Any) | mm-to-cm spectrum of 6 radio-bright RS CVn binaries | M.Guedel E.Fuerst S.L.Skinner J.L.Linsky A.Dutrey A.Brown | Cont | UX Ari, V711 Tau BH CVn, TZ CrB AR Lac, II Peg | Oth. |
| B047 | Any | Radio Continuum emission from stellar wind | P.Planesas J.Martin-Pintado J.Gomez-Gonzalez | Cont. | Vy 2-2, P Cyg, Wr 147 HD193793, Cyg OB2-12 | Oth. |
| B049 | BC | The high velocity gas of NGC 7027 | P.Cox S.Guilloteau A.Omont R.Bachiller T.Forveille P.G.Huggins | $HCO^+$ H41$\alpha$ | NGC 7027 | CSEs |

| Project | Conf. | Title | Authors | Molecules | Object | Type |
|---|---|---|---|---|---|---|
| B051 | C2<br>C1 | Searching for disk around young intermediate mass stars | P.Harvey N.Evans L.Mundy C.M.Walmsley | Cont. | LkH$\alpha$ 198, AB Aur<br>MWC 137, BD+404124<br>V1686 Cyg, V645 Cyg | YSO |
| B052 | CD | HCN and HNC chemistry in Orion KL | P.Schilke C.M.Walmsley | $HN^{13}C$ | Orion | Mol |
| C002 | BC | Small scale physical and chemical structure in the S140 HII region/molecular interface | J.Stutzki C.Degiacomi U.Corneliussen | $HCO^+$<br>$HC^{15}N$<br>$H^{13}CN$ | S140 | Mol. |
| C003 | BC | Small scale physical and chemical structure in the S140 HII region/molecular interface | J.Stutzki C.Degiacomi U.Corneliussen | $HC_5N$<br>$C^{34}S$<br>$N_2H^+$ | S140 | Mol. |
| C004 | CD | The exciting source of the molecular outflow near the FU Orionis RNO1B | B.LeFloch H.J.Staude Th.Neckel S.Guilloteau B.Lazareff | CO<br>$C^{17}O$ | RNO1B | YSO |
| C005 | C2 | IRAS 22036+5306 : a Young planetary nebula ? | M.Grewing R.Neri | $HCO^+$ | IRAS 22036+5306 | CSE |
| C006 | CD | Confirming the detection of low mass protostars | R.Gusten D.Fiebig | CS | GF9 | YSO |
| C007 | C2 | Continuum Observations of Uranus and Neptune | A.Marten D.Gautier S.Guilloteau A.Dutrey | CO | Uranus<br>Neptune | Sol |
| C008 | CD | The center of a cluster cooling flow: CO in NGC1275 | C.Henkel H.Lesh H.P.Reuter S.Radford B.Lazareff | CO | 3C84 | Gal |
| C015 | BC | Detailed photometry of the M 87 at 90 GHz | D.Fraix-Burnet A.Lannes E.Antérrieu | HCN<br>Cont. | M 87 | Oth |
| C017 | C2<br>(Any) | Millimeter Wavelength Interferometric Observations of 5 dMe Stars | M.Guedel A.O.Benz J.Lim L.Belkora | Cont. | V371 Ori, Gl 723<br>V1285 Aql, UV Ceti<br>EQ Peg | Other |
| C018 | B2 | The distribution of SiO Maser spots around evolved stars | J.Cernicharo A.Baudry V.Bujarrabal | SiO | NML Tau, R Cas<br>R Leo, R Aqr | CSE |
| C019 | BC | Dense gas in M82 the $N_2H^+$ mystery | C.Henkel S.Radford J.Wink R.Mauersberger | $N_2H^+$ | M 82 | Gal |
| C020 | BC | Distribution and dynamics of dense gas in the nucleus of NGC 1068 | L.Tacconi N.Anderson R.Genzel A.Harris S.Madden | HCN | NGC 1068 | Gal |

| Project | Conf. | Title | Authors | Molecules | Object | Type |
|---|---|---|---|---|---|---|
| C027 | BC | The molecular counterpart of the dust disk in the multiple star GG Tau | M.Simon S.Guilloteau A.Dutrey | $^{13}CO$ $C^{18}O$ | GG Tau | YSO |
| C029 | CD | The radial distribution of long carbon chains in IRC+10216 | R.Lucas M.Guélin C.Kahane J.Cernicharo | $C_4H$ $C_6H$ $C_3H$ $C_3S$ CS | IRC+10216 | CSE |
| C031 | B2 | $^{13}CO$ absorption in interstellar clouds | H.S.Liszt R.Lucas | $^{13}CO$ | 0212+735 0355+508 2200+420 | Mol Mol |

# 8. ANNEX II : PUBLICATIONS/ 8.1 IRAM PUBLICATIONS

325. DENSE MOLECULAR GAS AND STARBURSTS IN ULTRALUMINOUS GALAXIES
P.M. Solomon, D. Downes, S.J.E. Radford
1992, ApJ 387, L55

326. MOLECULAR GAS CONTENT OF THE PRIMEVAL GALAXY IRAS 10214+4724
P.M. Solomon, S.J.E. Radford, D. Downes
1992, Nature 356, 318

327. FABRICATION AND PROPERTIES OF SUPERCONDUCTOR-INSULATOR-NORMAL METAL TUNNEL JUNCTIONS
T. Lehnert, K.H. Gundlach
1992, Journ. Vacuum Sci. Technol. A10, 110

328. UNDERSTANDING NOISE IN SIS RECEIVERS
R. Blundell, R.E. Miller, K.H. Gundlach
1992, Int. Journ. IR & mm Waves 13, 3

329. A POWERFUL, ULTRA-STEEP SPECTRUM RADIO GALAXY HAVING AN EXTREMELY LOW-EXCITATION EMISSION LINE SPECTRUM
Gopal-Krishna, E. Giraud, J. Melnick, H. Steppe
1992, A&A 254, 42

330. CARBON MONOXIDE IN ACTIVE GALAXIES
R. Chini, E. Krügel, H. Steppe
1992, A&A 255, 87

331. ISOTOPIC ABUNDANCES IN CARBON RICH CIRCUMSTELLAR ENVELOPES: A FURTHER ITERATION ON THE OXYGEN ISOTOPE PUZZLE
C. Kahane, J. Cernicharo, J. Gomez-Gonzalez, M. Guélin
1992, A&A 256, 235

332. MONITORING OF THE RECOMBINATION LINE MASER IN MWC349
C. Thum, J. Martin-Pintado, R. Bachiller
1992, A&A 256, 507

333. A STUDY OF HCN, HNC AND THEIR ISOTOPOMERS IN OMC-1
P. Schilke, C.M. Walmsley, G. Pineau des Forêts, E. Roueff, D.R. Flower, S. Guilloteau
1992, A&A 256, 595

334. THE INTERNAL STRUCTURE OF MOLECULAR CLOUDS. III. EVIDENCE FOR MOLECULAR DEPLETION IN THE NGC 2024 CONDENSATIONS
R. Mauersberger, T.L. Wilson, P.G. Mezger, R. Gaume, K.J. Johnston
1992, A&A 256, 640

335. SIX YEARS OF MONITORING 3C273 AT MILLIMETRE WAVELENGTHS
H. Steppe
1992, A&A 259, 61

336. INTERFEROMETRIC OBSERVATIONS OF HCN (v = 2) EMISSION FROM IRC+10216
R. Lucas, S. Guilloteau
1992, A&A 259, L23

337. INTERSTELLAR DETECTION OF DEUTERATED METHYL CYANIDE
M. Gerin, F. Combes, G. Wlodarczak, T. Jacq, M. Guélin, P. Encrenaz, C. Laurent
1992, A&A 259, L31

338. THE PHYSICAL STRUCTURE OF THE SMALL AND ISOLATED COMETARY GLOBULE ORION-I-2
J. Cernicharo, R. Bachiller, G. Duvert, E. Gonzalez-Alfonso, J. Gomez-Gonzalez,
1992, A&A 261, 589

339. A SEARCH FOR MODERATE REDSHIFT CO ABSORPTION
N.G. Douglas, S.J.E. Radford, J. Roland, J.K. Webb
1992, A&A 262, 8

340. SEARCH FOR MOLECULAR GAS IN POLAR RING GALAXIES AND THE GIANT LOW SURFACE BRIGHTNESS GALAXY MALIN 1
S.J.E. Radford
1992, A&A 262, 13

341. THE ($^{12}$CO/$^{13}$CO) RATIO TOWARD $\zeta$ OPH
T.L. Wilson, R. Mauersberger, W.D. Langer, A.E. Glassgold, R.W. Wilson
1992, A&A 262, 248

342. HCN IN THE CENTER OF THE GALAXY IC342
D. Downes, S.J.E. Radford, S. Guilloteau, M. Guélin, A. Greve, D. Morris
1992, A&A 262, 424

343. INTERFEROMETRIC OBSERVATIONS OF SiO v = 0 THERMAL EMISSION FROM EVOLVED STARS
R. Lucas, V. Bujarrabal, S. Guilloteau, R. Bachiller, A. Baudry, J. Cernicharo, J. Delannoy, T. Forveille, M. Guélin, S.J.E. Radford
1992, A&A 262, 491

344. CRL 618 : THE NATURE OF THE 200 km $s^{-1}$ MOLECULAR OUTFLOW
R. Neri, S. Garcia-Burillo, M. Guélin, J. Cernicharo, S. Guilloteau, R. Lucas
1992, A&A 262, 544

345. THE IRAM INTERFEROMETER ON PLATEAU DE BURE
S. Guilloteau, J. Delannoy, D. Downes, A. Greve, M. Guélin, R. Lucas, D. Morris, S. Radford, J. Wink, J. Cernicharo, S. Garcia-Burillo, R. Neri, J. Blondel, A. Perrigouard, D. Plathner, M. Torres
1992, A&A 262, 624

346. INTERFEROMETRIC MEASUREMENTS OF TROPOSPHERIC PHASE FLUCTUATIONS AT 86 GHz ON SPACINGS OF 24m TO 288m
L. Olmi, D. Downes
1992, A&A 262, 634

347. FORMALDEHYDE IN COMETS: I. MICROWAVE OBSERVATIONS OF P/BROSEN-METCALF (1989 X), AUSTIN (1990 V) AND LEVY (1990 XX)
P. Colom, J. Crovisier, D. Bockelée-Morvan, D. Despois, G. Paubert
1992, A&A 264, 270

348. FIRST OBSERVATIONS OF YOUNG BIPOLAR OUTFLOWS WITH THE IRAM INTERFEROMETER : 2" RESOLUTION SiO IMAGES OF THE MOLECULAR JET IN L1448
S. Guilloteau, R. Bachiller, A. Fuente, R. Lucas
1992, A&A 265, L49

349. MOLECULAR GAS DISTRIBUTION AND DYNAMICS OF THE EDGE ON SPIRAL GALAXY NGC 891. DISCOVERY OF A MOLECULAR HALO
S. Garcia-Burillo, M. Guélin, J. Cernicharo, M. Dahlem
1992, A&A 266, 21

350. THE EDGE OF A MOLECULAR CLOUD : OBSERVATIONS OF MILLIMETRIC $^{13}CO$ AND $C^{18}O$ TRANSITIONS IN W 40
J.P. Vallée, S. Guilloteau, J.M. MacLeod
1992, A&A 266, 520

351. MILLIMETER CONTINUUM MEASUREMENTS OF EXTRAGALACTIC RADIO SOURCES (II)
H. Steppe, S. Liechti, R. Mauersberger, C. Kömpe, W. Brunswig, M. Ruiz-Moreno
1992, A&A Suppl. 96, 441

352. THERMAL BEHAVIOUR OF MM-WAVELENGTH RADIO TELESCOPES
A. Greve, M. Dan, J. Penalver
1992, IEEE Trans. Ant. Prop. 40, 1375

353. GAS CLOUD DYNAMICS IN SPIRAL GALAXIES
F. Combes, S. Garcia-Burillo, M. Gerin
1992, in Evolution of Interstellar Matter and Dynamics of Galaxies, ed. J. Palous, W.B. Burton. P.O. Lindblad. Cambridge University Press, 291

354. FIRST ABSOLUTE WIND MEASUREMENTS IN THE MIDDLE ATMOSPHERE OF MARS
E. Lellouch, J.J. Goldstein, S.W. Bougher, G. Paubert, J. Rosenqvist
1991, ApJ 383, 401

355. PROTONATED ACETYLENE : AN IMPORTANT CIRCUMSTELLAR AND INTERSTELLAR ION
A.E. Glassgold, A. Omont, M. Guélin
1992, ApJ 396, 115

356. DUSTY DISKS IN THE MULTIPLE SYSTEMS UZ TAU AND GG TAU
M. Simon, S. Guilloteau
1992, ApJ 397, L47

357. SUBMILLIMETER SPECTRUM AND DUST MASS OF THE PRIMEVAL GALAXY IRAS 10214+47
D. Downes, S.J.E. Radford, A. Greve, C. Thum, P.M. Solomon, J.E. Wink
1992, ApJ 398, L25

358. WARM DENSE GAS IN THE PRIMEVAL GALAXY IRAS 10214+47
P.M. Solomon, D. Downes, S.J.E. Radford
1992, ApJ 398, L29

359. MILLIMETER WAVE OBSERVATIONS OF SATURN, URANUS AND NEPTUNE : CO AND HCN ON NEPTUNE
J. Rosenqvist, E. Lellouch, P. Romani, G. Paubert, T. Encrenaz
1992, ApJ 392, L99

CO-6-5) AND CONTINUUM OBSERVATIONS OF THE PRIMEVAL GALAXY 10214+47 AT z = 2.3
P.M. Solomon, D. Downes, S.J.E. Radford
1992, Bull. Am. Astron. Soc. 24, 752

361. THE MOLECULAR SURROUNDINGS OF W3(OH)
J. Wink, S. Guilloteau, G. Duvert, C.M. Walmsley, R. Güsten, T.L. Wilson
1992, Astron. Ges. Abs. Ser. 7, 88

CUMULENE CARBENES IN SPACE AND IN THE LABORATORY
J.M. Vrtilek, C.A. Gottlieb, T.C. Killian, P. Thaddeus, J. Cernicharo, M. Guélin, G. Paubert
1992, in Astrochemistry of Cosmic Phenomena, IAU 150, ed. P.D. Singh, Kluwer, Dordrecht, 23

PANEL DISCUSSION : THE $CO/H_2$ ABUNDANCE RATIO
E.F. van Dishoeck, A.E. Glassgold, M. Guélin, D.T. Jaffe, D.A. Neufeld, A.G.G.M. Tielens, C.M. Walmsley
1992, in Astrochemistry of Cosmic Phenomena, IAU 150, ed. P.D. Singh, Kluwer, Dordrecht. 285

364. MOLECULES IN THE ENVELOPES OF LATE TYPE STARS
R. Lucas
1992, in Astrochemistry of Cosmic Phenomena, IAU 150, ed. P.D. Singh, Kluwer, Dordrecht, 389

365. OBSERVATIONS OF PARENT MOLECULES IN COMETS AT RADIO WAVELENGTHS : HCN, $H_2S$, $H_2CO$ and $CH_3OH$
P. Colom, D. Bockelée-Morvan, J. Crovisier, D. Despois, G. Paubert
1992, in Astrochemistry of Cosmic Phenomena, IAU 150 ed. P.D. Singh, Kluwer, Dordrecht, 439

LEAD/BISMUTH AND NIOBIUM BASED SIN TUNNEL JUNCTIONS
T. Lehnert, K.H. Gundlach, H. Kohlstedt
1992, in Superconducting Devices & Applications, ed H. Koch, H. Lübbig, Springer, Berlin, 214

THERMAL ANNEALING PROPERTIES OF Nb-Al/$AlO_x$-Nb TUNNEL JUNCTIONS
T. Lehnert, D. Billon-Pierron, C. Grassl, K.H. Gundlach
1992, J. Appl. Phys. 72, 3165

368. SUPRALEITER-ISOLATOR-SUPRALEITER UND SUPRALEITER-ISOLATOR-NORMALLEITER TUNNELELEMENTE AUS NIOB UND ALUMINIUM FÜR MILLIMETERWELLEN EMPFÄNGER
T. Lehnert
1992, Doctoral Thesis, Univ. Würzburg

369. PREPARATION AND PROPERTIES OF Nb/Al SIS AND SIN JUNCTIONS FOR MILLIMETER AND SUBMILLIMETER RADIOASTRONOMICAL RECEIVERS
K.H. Gundlach, T. Lehnert, D. Billon-Pierron, P. Pasturel
1992, in Photon Detectors for Space Instrumentation, ESA SP-356, ESTEC, Noordwijk, 313

370. THE STRUCTURE, STABILITY AND GLOBAL DISTRIBUTION OF IO'S ATMOSPHERE
E. Lellouch, M. Belton, I. de Pater, G. Paubert, S. Gulkis, T. Encrenaz
1992, Icarus 98, 271

371. OBSERVATIONS AT (SUB)MILLIMETRE WAVELENGTHS : EFFECT OF ATMOSPHERE AND TELESCOPE SIDELOBES
M. Guélin
1992, in the Infrared and Submillimetre Sky after COBE, ed. M. Signore, C. Dupraz et al., Kluwer. Dordrecht. 423

372. DISTRIBUTION OF MOLECULAR GAS IN THE PRIMEVAL GALAXY IRAS 10214+4724
S.J.E. Radford, R.L. Brown, P.A. Vanden Bout
1992, BAAS 24, 1124

373. S-BEARING MOLECULES IN O-RICH CIRCUMSTELLAR ENVELOPES
A. Omont, R. Lucas, M. Morris, S. Guilloteau
1993, A&A 267, 490

374. $H_2O$ MASERS IN NEARBY IRREGULAR GALAXIES
R. Becker, C. Henkel, T.L. Wilson, J.G.A. Wouterloot
1993, A&A 268, 483

375. A SEARCH FOR PARENT MOLECULES AT MILLIMETRE WAVELENGTHS IN COMETS AUSTIN 1990V AND LEVY 1990XX : UPPER LIMITS FOR UNDETECTED SPECIES
J. Crovisier, D. Bockelée-Morvan, P. Colom, D. Despois, G. Paubert
1993, A&A 269, 527

# 8. ANNEX II : PUBLICATIONS/ 8.2 USERS's PUBLICATIONS


237. ANALISI E MISURA DEL SEEING ASTRONOMICO A λ mm E sub-mm MEDIANTE L'ANALISI DELLE FLUTTUAZIONI DI FASE TROPOSFERICHE CON UN INTERFEROMETRO
L. Olmi
1992, Doctoral Thesis, Universita degli Studi di Firenze

238. CONDICIONES FISICAS Y QUIMICAS EN NUBES MOLECULARES CON FORMACION ESTELAR RECIENTE
A. Fuente
1992, Doctoral Thesis, Universidad Autonoma de Madrid

239. A FAST CO JET IN ORION B
J.S. Richer, R.E. Hills, R. Padman
1992, Mon. Not. Roy. Astr. Soc. 254, 525

240. INTERSTELLAR DETECTION OF DEUTERATED METHYL ACETYLENE
M. Gerin, F. Combes, G. Wlodarczak, P Encrenaz, C. Laurent
1992, A&A 253, L29

241. HOT, DENSE, MOLECULAR GAS ASSOCIATED WITH ULTRACOMPACT H II REGIONS
E. Churchwell, C.M. Walmsley, D.O.S. Wood
1992, A&A 253, 541

242. SiO EMISSION AS A TRACER OF SHOCKED GAS IN MOLECULAR OUTFLOWS
J. Martin-Pintado, R. Bachiller, A. Fuente
1992, A&A 254, 315

243. MILLIMETER RECOMBINATION LINES IN THE PLANETARY NEBULA BD+30°3639
R. Bachiller, P.J. Huggins, J. Martin-Pintado, P. Cox
1992, A&A 256, 231

244. THE MOLECULAR CLOUD CONTENT OF EARLY TYPE GALAXIES III. A NUCLEAR MOLECULAR RING IN NGC3593
T. Wiklind, C. Henkel
1992, A&A 257, 437

245. THE MOLECULAR EMISSION OF YOUNG PREPLANETARY NEBULAE
V. Bujarrabal, J. Alcolea, P. Planesas
1992, A&A 257, 701

246. THE SMALL SCALE DENSITY AND VELOCITY STRUCTURE OF QUIESCENT MOLECULAR CLOUDS
E. Falgarone, J.L. Puget, M. Pérault
1992, A&A 257, 715

247. MOLECULAR CLOUDS IN A POLAR RING
F. Combes, J. Braine, F. Casoli, M. Gerin, W van Driel
1992, A&A 259, L65

248. GALAXY PHOTOMETRY AT MILLIMETRIC WAVELENGTHS
P. Andreani, A. Franceschini
1992, A&A 260, 89

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# 9. ANNEX III - IRAM Executive Council and Committee Members, January 1992

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