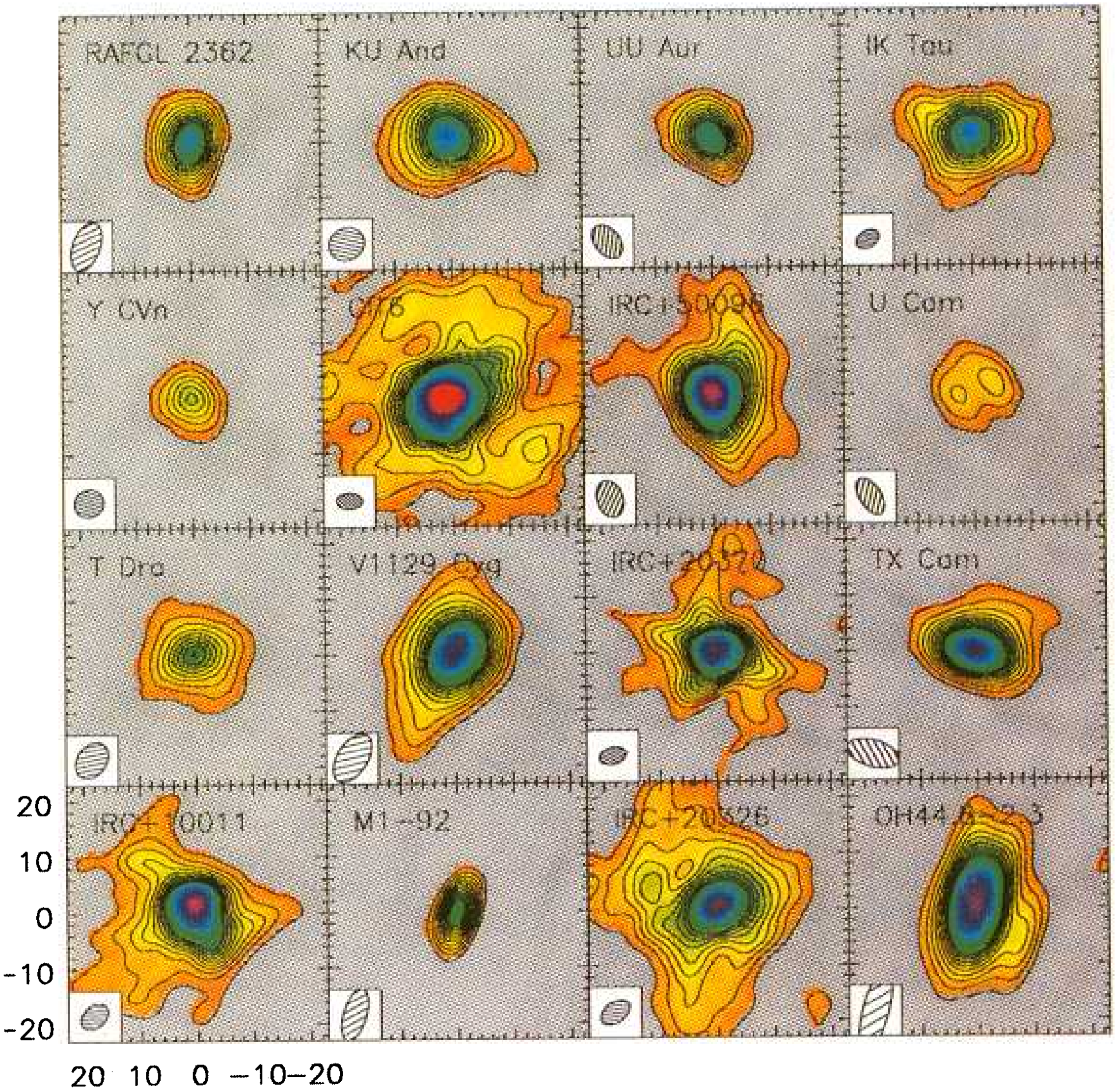
IRAM 1997



ANNUAL REPORT

Front Cover : The evolution of transition objects between the asymptotic giant branch (AGB) stage and the planetary nebula phase is known to be a crucial moment where very efficient mass loss phenomena modify the basic morphological, kinematical and chemical structure of the newly born planetary nebula. High resolution observations of ^{12}CO yield unique data on the geometry and dynamics of the envelopes and the mass loss rates from the stars. These maps were obtained by observing the CO(1-0) line emission. They show the velocity integrated distribution of the molecular gas in a selected sample of circumstellar envelopes. The dynamic range of the observations is large enough to show that in about 30% of all cases the envelopes are definitely asymmetric.

The high resolution maps were obtained by combining visibilities from snapshot observations with the IRAM Plateau de Bure interferometer with short spacing observations from the 30m-telescope. Coordinates are offsets from the positions of the stars in units of arcsec. The synthesised beams are shown as insets. Contour levels are from 200 mJy/beam to 1 Jy/beam in steps of 100 mJy/beam. The maps come from a systematic survey of circumstellar shells of AGB and post-AGB stars (from Neri et al. 1998, AASS (in press)).

ANNUAL REPORT
1997

Edited by

Michael Grewing

with contributions from:

Walter Brunswig
Gilles Butin
Thierry Crouzet
Dennis Downes
Michel Guélin
Stéphane Guilloteau
Bernard Lazareff
Javier Lobato
Manfred Malzacher
Santiago Navarro
Robert Neri
Juan Peñalver
Alain Perrigouard
Jean-Louis Pollet
Karl Schuster
Marc Torres
Wolfgang Wild

INSTITUT DE RADIO ASTRONOMIE MILLIMETRIQUE
INSTITUT FÜR RADIOASTRONOMIE IM MILLIMETERBEREICH
INSTITUTO DE RADIOASTRONOMIA MILIMETRICA
300 Rue de la Piscine
Domaine Universitaire de Grenoble
38406 SAINT MARTIN D'HERES
France

TABLE OF CONTENTS

1. INTRODUCTION

One of the most significant events for IRAM in 1997 was undoubtedly the decision of the IRAM Council to fund a 6th antenna for the Plateau de Bure Interferometer. The scientific case for this extension had been discussed by the Council and by the Advisory Committees during the years before, and the Council was now ready to adopt a funding scheme in which all three IRAM partners make the same contribution to the remaining cost of this antenna, after the purchase of an additional set of surface panels had already been authorised by the Council the year before. The funding scenario that was adopted necessitated an amendment to the CNRS/IGN/MPG IRAM-agreement which was prepared during the second half of the year. The 6-element array is now planned to be ready for commissioning just before the end of the decade. With this extension, it will remain a leading instrument for many years to come.

1997 has also brought a number of important changes at the management level. The Head of Administration, Manfred Malzacher, retired by the end of July, and he was replaced by Michael Lange. One month later, Bernard Lazareff ended his term as Deputy Director of IRAM, and Stephane Guilloteau took over this responsibility, starting September 1st. Finally, Bernard Lazareff was appointed as Head of the receiver group, a capacity in which he has been acting before, and Karl Schuster was appointed as the new Head of the SIS group, succeeding Karl-Heinz Gundlach, who had reached retirement age some time before but who continues to be actively involved in the SIS development work. As a consequence of this new distribution of responsibilities, a number of other tasks had to be redistributed, too, among them the co-ordination of the Plateau de Bure operations which went to Roberto Neri.

As Chapter 2 of this report will show, 1997 has been scientifically as successful as previous years, despite all these changes. The scientific highlights include again several important new discoveries which underline the enormous potential of high spatial and spectral resolution observations at millimetre wavelengths. This potential is more and more being recognised by astronomers who are not traditionally working in the field of millimetre-wave astronomy but now start to use the IRAM facilities.

Technically, very important steps have been taken at both the 30m telescope on the Pico Veleta, and at the 15m telescopes of the interferometer on the Plateau de Bure, to further improve their surface accuracy. For the 30m telescope is has for the first time since years been possible to reduce the rms-deviation from an ideal parabolic surface by more than 20% to a value in the range of 60-70 µm, a result that is confirmed by the increased beam efficiency of the telescope at higher frequencies. For the 15m telescope of the interferometer, their surfaces have been set to an accuracy in the range of 50-60 µm rms, and work has started to refurbish the surfaces of Antennas 1 to 4. The thin, backside aluminised plastic layers which have been put on top of the carbon-fibre body of the panels of these telescopes developed tiny pinholes which cause oxydisation of the aluminium and sooner or later delamination of the plastic foil. One complete set of such panels, on Antenna 3, has been dismounted in 1997 and replaced by a new set of aluminium panels, a solution that had already been adopted for Antenna 5. During 1998 those of the dismounted panels which show only few pinholes so far will go to one of the other antennas, the others will eventually receive a conductive paint cover after removal of the plastic foil. It is planned to finish this refurbishment work before the spare set of panels is needed on Antenna 6, i.e. before the autumn of 1999.

1997 also saw intensive study activities in connection with the IRAM/ESO/NFRA/OSO effort to prepare a conceptual design study for a large southern hemisphere array (LSA). An important milestone in this effort was the completion of a technical report that addressed various aspects of such a project, including an innovative design for high-precision 15m-diameter telescopes that builds on the experience gained with the construction of the Plateau de Bure antennas. Another important milestone was the signature of a "Resolution" in June 1997 between the ESO and the NRAO at a meeting in Charlottesville,USA in which these organisations agree to organise a partnership that will explore the union of the LSA and MMA projects into a single, common project to be located in Chile. Since then this has become the baseline scenario for the European study efforts which continue at present with the preparation of a "Feasibility Study" document to be submitted to the ESO Council in June 1998.

The LSA/MMA is planned as the next big project in ground-based astronomy in Europe, and in the US. Similarly, space projects like the ESA mission FIRST are also entering a phase of intensive study and prototyping of instrumentation, and IRAM has participated in some of these efforts, although on a very limited basis. Overviews over these activities were given during a joint ESA/IRAM FIRST-related Symposium on "The Far Infrared and Submillimetre Universe" in April 1997, and again during the "5th International Workshop on Terahertz Electronics" which IRAM organised in September 1997.

The fact that IRAM staff is actively involved in the preparation of some of these new projects will open up new possibilities for future research and development. At the same time, the results reported here show that today's focus must be on the full exploitation of the potential of the existing IRAM facilities and their further enhancement.

2. SCIENTIFIC HIGHLIGHTS OF RESEARCH WITH THE IRAM TELESCOPES IN 1997

2.1 SUMMARY

Some highlights of projects at the IRAM telescopes that were done or published in 1997 were:

- The detection of CO in a second quasar at redshift larger than 4.
- Detection of CO(3-2) from the gravitationally lensed quasar MG 0414+0534 at z = 2.6.
- A new map of the CO emission in the Cloverleaf quasar, and a model that includes the contribution of a galaxy cluster at z ~ 1.7 to the gravitational lens.
- New subarcsecond-resolution maps of rotating nuclear disks in ultraluminous infrared galaxies.
- New maps of very broad (1100 km/s) CO emission in the spectacular ring galaxy NGC 1144.
- Detection at 3mm of the afterglow of the gamma-ray burst source of May 8, 1997.
- New maps of the molecular gas in the spiral arms of the Andromeda galaxy.
- Analysis of wide-field mapping of the 1.3mm dust emission from the rho Oph cloud.
- New maps of the SiO emission from the molecular clouds in the galactic center.
- Detection of the molecular ion CO^+ toward the reflection nebula NGC 7023.
- A CO atlas of circumstellar envelopes of AGB and post-AGB stars.
- Maps of a remarkably thin shell of molecular gas around the carbon star TT Cygni.
- Detection at 3mm of the pulsar PSR B0355+54.
- Observations of line and continuum emission from Comet Hale-Bopp.

EXTRAGALACTIC RESEARCH

Distant Sources

Detection of CO in a second quasar at redshift larger than 4

The IRAM interferometer has been used to detect the CO(5-4) line, redshifted to 3 mm, in the quasar BRI 1335-0415 at a redshift of z = 4.4. After BR 1202-0725 at z = 4.7 (Ohta et al. 1996; Omont et al. 1996), this is the second detection of CO at $z > 3$. The line intensity is 2.8 Jy km/s and the linewidth is 420 km s^{-1}. The dust continuum emission has also been detected at 1.4 mm, with a flux of 5.6 mJy. The ratio of the CO to 1.4 mm continuum flux is slightly larger than for BR 1202-0725. Unlike BR 1202-0725, the 1.4 mm continuum and 3 mm CO sources are only marginally extended. In the absence of gravitational lensing, for which there is no evidence so far, the mass of the molecular gas could be 10^{11} $M_{\odot}$.

Detection of CO(3-2) from the Gravitationally Lensed Quasar MG 0414+0534 at z = 2.6

CO (3-2) line emission has been detected from the gravitationally lensed quasar MG 0414+0534 at redshift 2.64, with the IRAM Interferometer. The line is broad (580 km s^{-1}), and the CO flux is comparable to, but somewhat smaller than, that of IRAS F10214+4724 and the Cloverleaf quasar (H1413+117), both of which have similar redshifts. The lensed components A1 + A2 and B were resolved, and separate spectra were obtained for each component. The unlensed radio-quiet quasar PG 1634+706 at z = 1.33, was also searched, but no CO was detected.

Multiple CO Transitions, and CI from the Cloverleaf Quasar

New millimeter-wavelength emission lines have been detected with the 30m telescope from the Cloverleaf (H1413+117), a gravitationally lensed quasar at redshift 2.56. High-sensitivity spectra of the four CO lines, CO(3-2), (4-3), (5-4), and (7-6), show line brightness temperatures that appear to be flat or rising between CO(3-2) and (4-3) and then falling off in the CO(5-4) and (7-6) lines. This falloff suggests that the optical depths in the CO lines are modest ($\tau_{4-3} < 3$), and that the gas is warm (T > 100 K) and dense ($n_{H2} > 3 \times 10^3$ cm^{-3}). The neutral carbon fine structure line C I($^3P_1 \rightarrow {}^3P_0$) was tentatively detected with moderate signal-to-noise on two separate occasions. The detectability of the Cloverleaf in molecular and neutral atomic transitions appears to be due to high emissivity of the gas and magnification from gravitational lensing, rather than an extremely large mass of gas.

Modelling the Cloverleaf: Contribution of a Galaxy Cluster at z ~ 1.7

The Cloverleaf quasar ($z = 2.558$) was analysed with archival Hubble Space Telescope (HST) data, recent IRAM CO (7-6) maps, and data from the Canada-France-Hawaii telescope. An HST observation shows many 23-25th magnitude galaxies around the Cloverleaf that are interpreted as a cluster of galaxies on the line of sight. The magnitudes, red colors (R-I ~ 0.9) and small angular sizes of these galaxies imply the cluster is very distant and could be associated with the absorption lines observed in the spectra of the quasar spots at $z= 1.438$, 1.66, 1.87, and 2.07. The Cloverleaf pattern probably results from combined gravitational lensing by a single galaxy and one of the most distant clusters of galaxies ever detected. The HST data were used with the IRAM CO (7-6) map for two lens models: (1) a galaxy and a dark halo at $z = 1.7$, and (2) a cluster and an individual galaxy, both at $z = 1.7$. The CO map yields the orientation and ellipticity of the CO spots induced by the shear component. Velocity - position shifts are seen at an 8σ level in the CO map, which constrain the CO source size. The CO appears to be in a 100-pc disk or ring around the quasar rotating at ~ 100 km/s, which implies a central mass of ~ 10^9 $M_{\odot}$. The cluster of galaxies increases the lens convergence and halves the mass needed in the lensing galaxy, possibly explaining why the lensing galaxy has not yet been detected. A deep infrared image should reveal the lensing galaxy. The presence of a lensing cluster on the line of sight is further evidence that many bright quasars are magnified by distant clusters of galaxies at redshifts larger than 1.

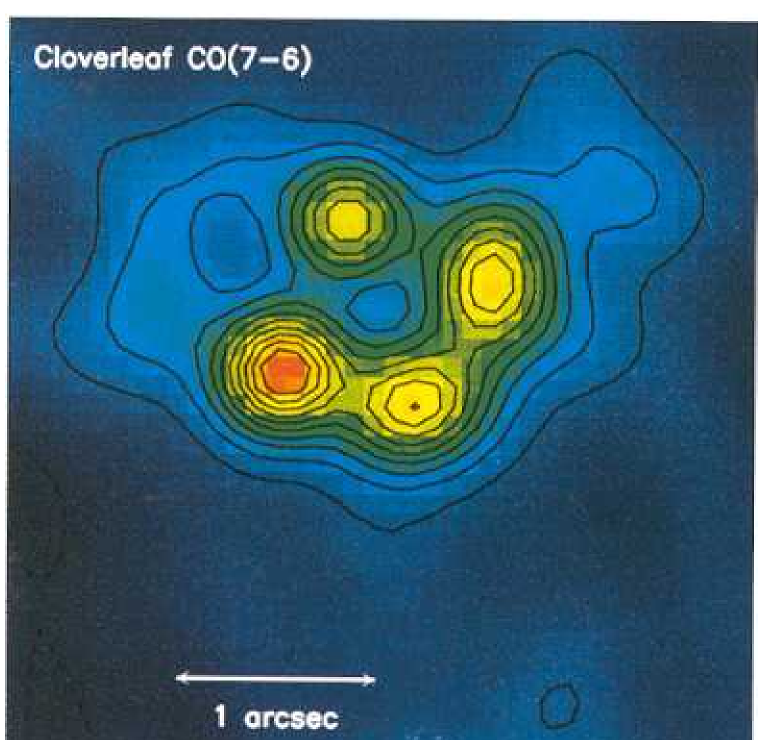


Fig. 2.1 CO in the Cloverleaf quasar at a redshift of 2.56. The CO(7-6) line was mapped with the IRAM interferometer with an 0.6'' beam. The gravitational lens distorts the image of the molecular gas into four spots with a separation of about 1 arcsec.

Rotating Nuclear Disks in Ultraluminous Galaxies

New data from the IRAM interferometer show the molecular gas in IR ultraluminous galaxies is in rotating nuclear disks or rings. The CO maps yield disk radii, kinematic major axes, rotation speeds, enclosed dynamical masses, and gas masses. The CO brightness temperatures, the double peaked CO line profiles, the limits on thermal continuum flux from dust, and the constraint that the gas mass must be less than the dynamical mass, all indicate the CO lines are subthermally excited and moderately opaque ($\tau = 4$ to 10). The data can be fit with kinematic models in which most of the CO flux comes from a moderate-density, warm, intercloud medium rather than virialized clouds. This allows gas masses to be derived not from a standard CO-to-mass ratio, but from a model of radiative transfer through subhtermally excited CO in the molecular disks. This model yields gas masses ~ 5 times lower than the standard method, and a ratio $M_{gas}/L'_{CO} \approx 0.8\ M_{\odot}\ (K\ km\ s^{-1}\ pc^2)^{-1}$. In the nuclear disks, the ratio of M_{gas}/M_{dyn} is 1/6 and the maximum ratio of gas to total mass surface density, μ/μ_{tot}, is 1/3.

In the galaxies VII Zw 31, Arp 193, and IRAS 10565+2448, the CO position-velocity diagrams indicate rotating molecular rings with a central gap.

In Mrk 231, the CO (2-1) velocity diagram along the line of nodes shows a 1"2-diameter inner disk and a 3"-diameter outer disk. The narrow CO linewidth, the single-peak line profile, the equality of the major and minor axes, and the observed velocity gradients all imply the molecular disk is nearly face-on, yielding low optical and UV extinction to the AGN. Such a geometry means that the molecular disk cannot be heated by the AGN; the FIR luminosity of Mrk 231 is powered by a starburst, not the AGN.

In Mrk 273, the CO (1-0) maps show long streamers of radius 5 kpc (7") with a north-south velocity gradient, and a nuclear disk of radius 400 pc (0.6") with an east-west velocity gradient. This nuclear disk contains a compact CO core of radius 120 pc (0.2").

In Arp 220, the CO and 1.3 mm continuum maps show the two nuclei embedded in a central ring or disk. Models of the CO and dust flux indicate that the two K-band nuclei contain high-density gas with $n\ (H_2) = 2 \times 10^4\ cm^{-3}$. The CO maps also trace the molecular disk at p.a. 59° and a second structure extending 7" (3 kpc) to the east, normal to the nuclear disk. The luminosity to mass ratios for the CO sources in Arp 220 are compatible with the early phases of compact starbursts. There is a large mass of molecular gas currently forming stars with plenty of ionizing photons, and no obvious AGN. The entire bolometric luminosity of Arp 220 comes from starbursts, not an AGN.

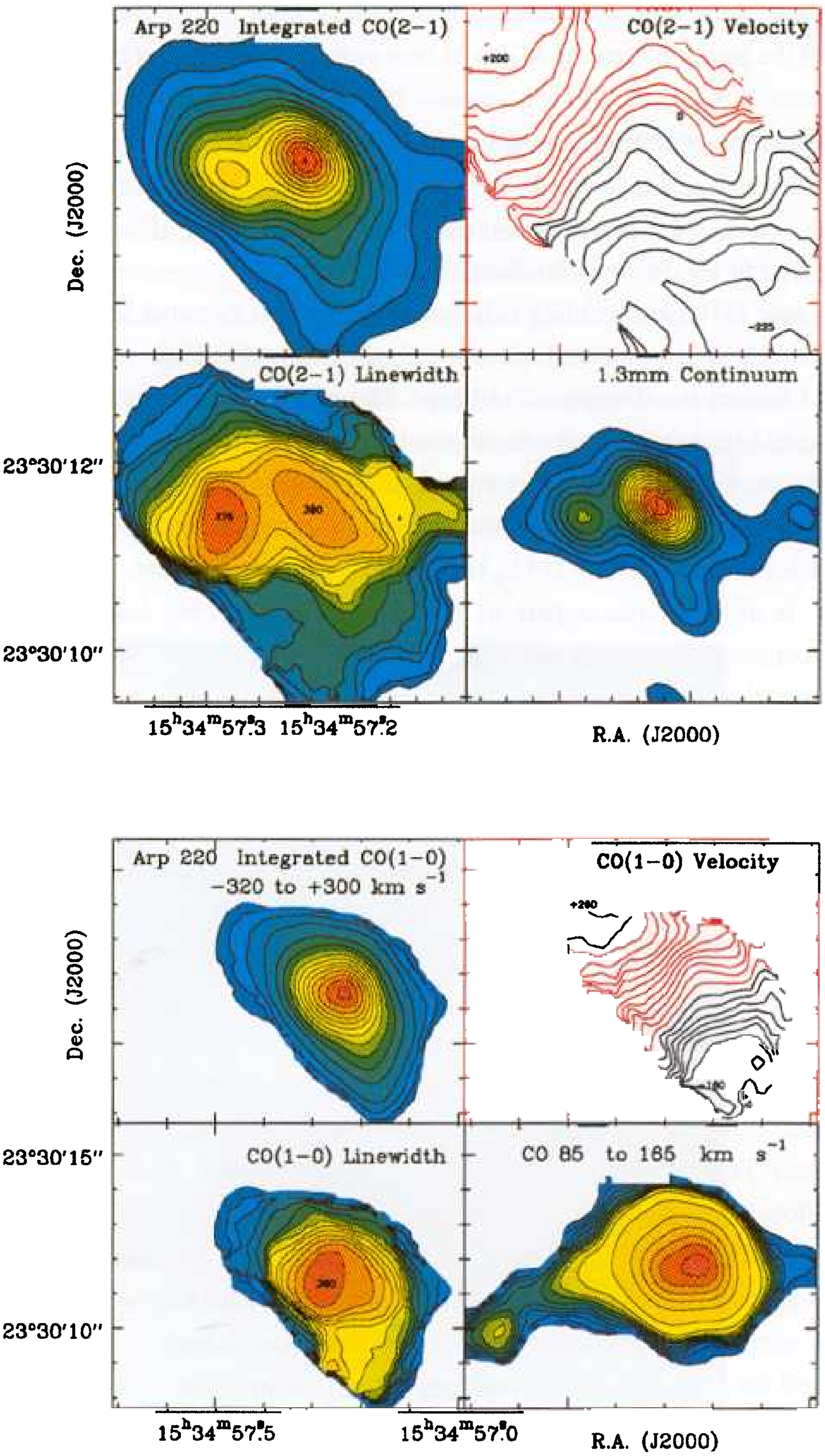


Fig. 2.2 Interferometer maps of CO and dust in the merger galaxy Arp 220. --- The four upper panels show maps at 1.3 mm, with a beam of 0.6 arcsec, of CO(2-1) intensity, velocity, and linewidth. The 4^{th} panel shows the 1.3 mm thermal emission from dust. The maps show the two nuclei embedded in a rotating disk of gas. The four lower panels show similar maps at 2.6 mm, with a beam of 1.2 arcsec, of CO(1-0) intensity, velocity, and linewidth. The 4^{th} panel at lower right shows a streamer of molecular gas in a more limited range of velocity.

The CO maps show the gas in ultraluminous IR galaxies is in extended disks that cannot intercept all the power of central AGNs, if they exist. It thus appears that in ultraluminous IR galaxies --even Mrk 231 that hosts a quasar -- the far IR luminosity is powered by starbursts in the molecular rings or disks, not by dust-enshrouded quasars.

Molecular Gas in the Spectacular Ring Galaxy NGC 1144

Extremely wide (1100 km s^{-1}) CO(1-0) emission has been detected with the 30m telescope from NGC 1144, an interacting, luminous infrared galaxy that is the dominant component of the Arp 118 system at a distance of 118 Mpc. The observations show that NGC 1144 is one of the most CO luminous galaxies in the local universe, with a CO luminosity twice that of Arp 220. Maps with the IRAM interferometer show that the CO is not in or very near the Seyfert 2 nucleus, but in the 20 kpc diameter ring that extends halfway between NGC 1144 and the elliptical galaxy NGC 1143. The greatest gas concentration, with 40% of the CO luminosity, is in the southern part of the ring, in NGC 1144. Another 15% of the CO luminosity comes from the dominant 10μm source, a giant extranuclear HII region. The ring of molecular gas, the off-center nucleus, the ring extending halfway to the intruder, and the velocity of the intruder nearly equal to the escape velocity all show that Arp 118 is a ring galaxy produced by a collision of a massive spiral with an elliptical. The most spectacular property is the velocity range, which in Arp 118 is 2 to 3 times higher than in a typical ring galaxy. Arp 118 is a rare example of a very luminous extended starburst with a scale of about 5-10 kpc, and a luminosity of 3×10^{11} L_{O}.

Detection at 3mm of the gamma-ray burst source GRB 970508

The gamma-ray burst source GRB 970508, believed to have originated in a distant galaxy at redshift >0.85, has been detected as a continuum point source at 86.2 GHz with the IRAM Interferometer. From observations on May 17, 19, 21, and 22, the flux is 1.62±0.25 mJy, a 6.5σ detection. Observations at 232 GHz gave only upper limits of 4.5 mJy (3σ) on May 19 and 21. No significant variation of the source was seen during individual observing runs. Three individual tentative detections were made at 3 mm on May 19-22, and the source was not detected in later 3mm observations to 3σ upper limits of 0.9 to 1.8 mJy. The May 17-22 detection and the later non-detections imply a significant fading, faster than the $t^{-1.1\pm0.1}$ law found at higher frequencies. The 86.2 GHz fluxes cannot have been modulated significantly by interstellar scintillation, so the millimetre fading of GRB 970508 must be due to the intrinsic evolution of the source.

2.2.2 Nearby Galaxies

The Andromeda Galaxy

The CO J=1- 0 line survey of the Andromeda galaxy made with the IRAM 30m telescope (see the annual report 1995) has been extended in size and covers now about one third of the bright stellar disk. Contrary to claims based on lower resolution surveys, there is no evidence for large-scale streaming motions within the CO arms. These motions were probably the result of an over-estimation of the arm thickness and of the rotation gradient across the arm. Instead of such systematic motions, the new IRAM data show broad two-component profiles at many places. The broadest profiles have widths of 40 – 60 km/s and are observed in the immediate vicinity of bright HII regions, as illustrated in the figure below; they are linked to star formation activity. Such motions, which involve kinetic energies > 10^{51} ergs, would have been difficult to notice in the Galaxy because of confusion along the line-of-sight.

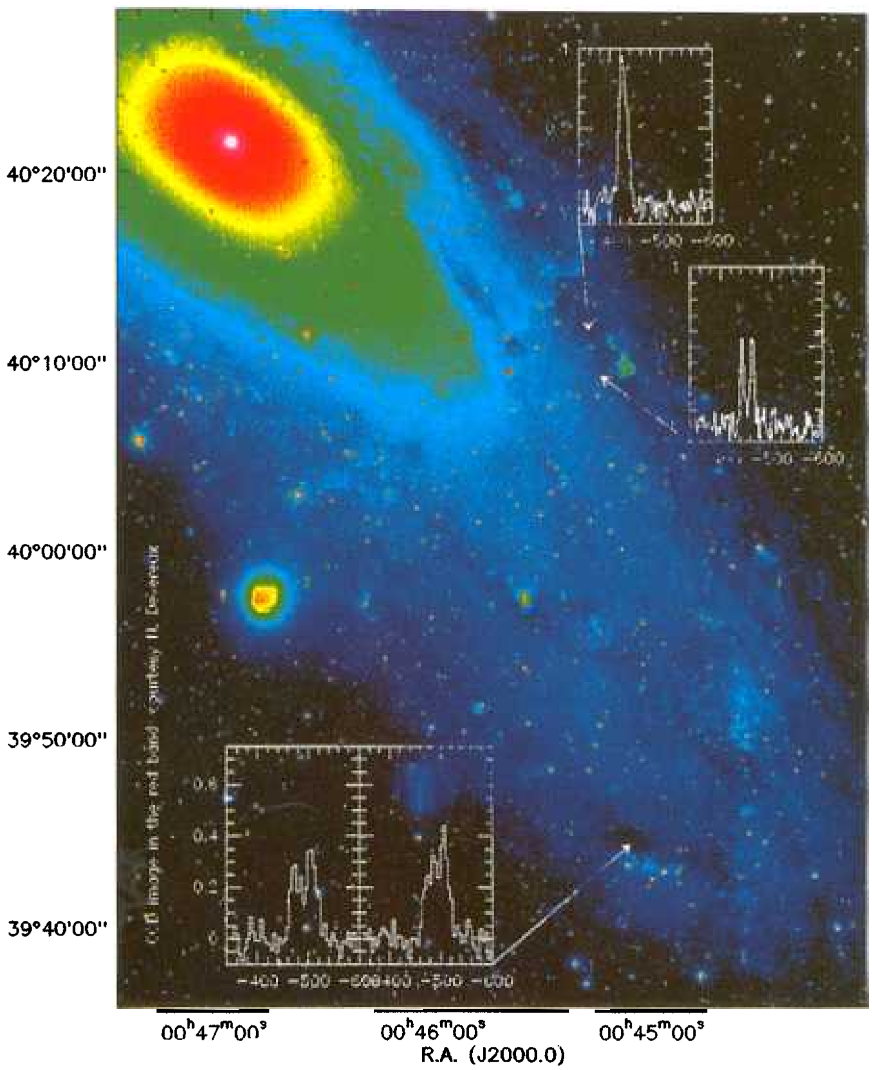


Fig. 2.3 CO J=1- 0 line profiles observed with the 30m telescope in the vicinity of the brightest HII regions of M 31's south-west half

2.3 YOUNG STELLAR OBJECTS

Star formation in the ρ Ophiuchi main cloud: wide-field millimeter continuum mapping

An extensive 1.3 mm continuum mosaic map of the ρ Ophiuchi central region has been done at the IRAM 30-m telescope with the MPIfR 19-channel bolometer array. The mosaiced field covers a total area of ~480 arcmin^2, corresponding to ~1 pc^2 at a distance of 160 pc, and includes the DCO^+ dense cores Oph-A, Oph-B1, Oph-B2, Oph-C, Oph-D, Oph-E, and Oph-F. The mosaic is sensitive to features down to $N_{H2} \sim 10^{22}$ cm^{-2} in column density. It is consistent with, but goes signifcantly deeper than, previous dust continuum studies of the cloud. For the first time, compact circumstellar dusty structures around young stellar objects are detected simultaneously with more extended emission from the dense cores and the ambient cloud. Thus, it becomes possible to directly study the genetic link between dense cores and young stars.

The diffuse cloud emission is itself fragmented in at least 58 small-scale, starless clumps harboring no infrared or radio continuum sources in their centers. Most of these starless fragments are probably gravitationally bound and pre-stellar in nature. Several of them exhibit a relatively flat inner intensity profile, indicating they are not as centrally condensed as the envelopes seen around the embedded (Class I and Class 0) protostars of the cloud. Ten other clumps appear to be sharply peaked, however, and may represent candidate 'isothermal protostars', i.e. collapsing cloud fragments which have not yet developed a central hydrostatic core. The ~6000 AU fragmentation scale estimated from the ρ Oph 1.3 mm mosaic is consistent with the typical Jeans length in the DCO^+ cores and is at least five times smaller than the diameter of isolated dense cores in the Taurus cloud. In agreement with this short fragmentation length, the circumstellar envelopes surrounding ρ Oph Class I and Class 0 protostars are observed to have finite sizes and to be significantly more compact than their Taurus counterparts.

The frequency distribution of pre-stellar clump masses is relatively shallow below ~0.5 $M_{\odot}$, with DN/dm varying as $m^{-1.5}$, but steepening to $m^{-2.5}$ in the ~0.5-2 $M_{\odot}$ mass range. This is reminiscent of the stellar initial mass function (IMF), suggesting the clumps are the direct progenitors of individual stars. The observations thus support scenarios in which gravitational fragmentation plays a key role in determining the stellar mass scale and the IMF. However, some remarkable alignments of young stars and starless clumps in the 1.3 mm dust continuum mosaic also support the idea that an external agent, such as a slow shock wave originating in the Sco OB2 association, has induced core fragmentation and star formation in at least part of the cloud.

SiO Emission from the Galactic Center Molecular Clouds

The SiO lines from the Galactic center have been mapped by combining results from the 14m telescope of the Centro Astronomico de Yebes with data from the IRAM 30m telescope. The SiO(1-0) line was mapped in a 1° x 12' (1 x *b*) region with a 2' (4 pc) beam with the Yebes telescope, and the SiO(2-1) line was mapped with a 26″ beam at the 30m telescope. In contrast to the spatial distribution of other high dipole moment molecules like CS, whose emission is nearly uniform, the SiO emission is very fragmented and associated with only some of the molecular clouds. In particular, the SiO emission follows closely the nonthermal radio arc in the galactic center. The SiO clouds are more extended than the beam, with typical sizes between 4 and 20 pc. High-resolution mapping in SiO(2-1) toward Sgr B2 and Sgr A shows the SiO emission is relatively smooth, with structure on the 2 pc scale. From SiO(2-1), (3-2), and (5-4) line intensities, the H_2 densities in these clouds are about 10^4 cm^{-3}. The SiO fractional abundances are $\sim 10^{-9}$ for the SiO clouds and $<10^{-10}$ for the other molecular clouds in the Galactic center. The size scales and H_2 densities characteristic of the SiO emission in the Galactic center are completely different from those observed in the Galactic disk, where the SiO emission arises from much smaller regions with larger H_2 densities. The unusual chemistry in the galactic center clouds is probably related to large-scale fast shocks in the region.

Detection of CO^+ toward the Reflection Nebula NGC 7023

The 30m telescope has been used to detect CO^+ toward the photon-dominated region (PDR) associated with the reflection nebula NGC 7023. This is the first detection of CO^+ in the vicinity of a Be star. A CO^+ column density of 3 x 10^{11} cm^{-2} has been derived toward the PDR peak. However, CO^+ is not seen in a well-shielded clump of the adjacent molecular cloud, where the CO^+/HCO^+ abundance ratio is at least 100 times lower than in the PDR. The results show, for the first time, that CO^+ column densities as large as 3 x 10^{11} cm^{-2} can be produced in regions with low levels of incident UV radiation and densities $\leq 10^5$ cm^{-3}. Furthermore, because the ionization potential of CO is larger than 13.6 eV, the data rule out the direct photoionization of CO as a significant formation mechanism for CO^+.

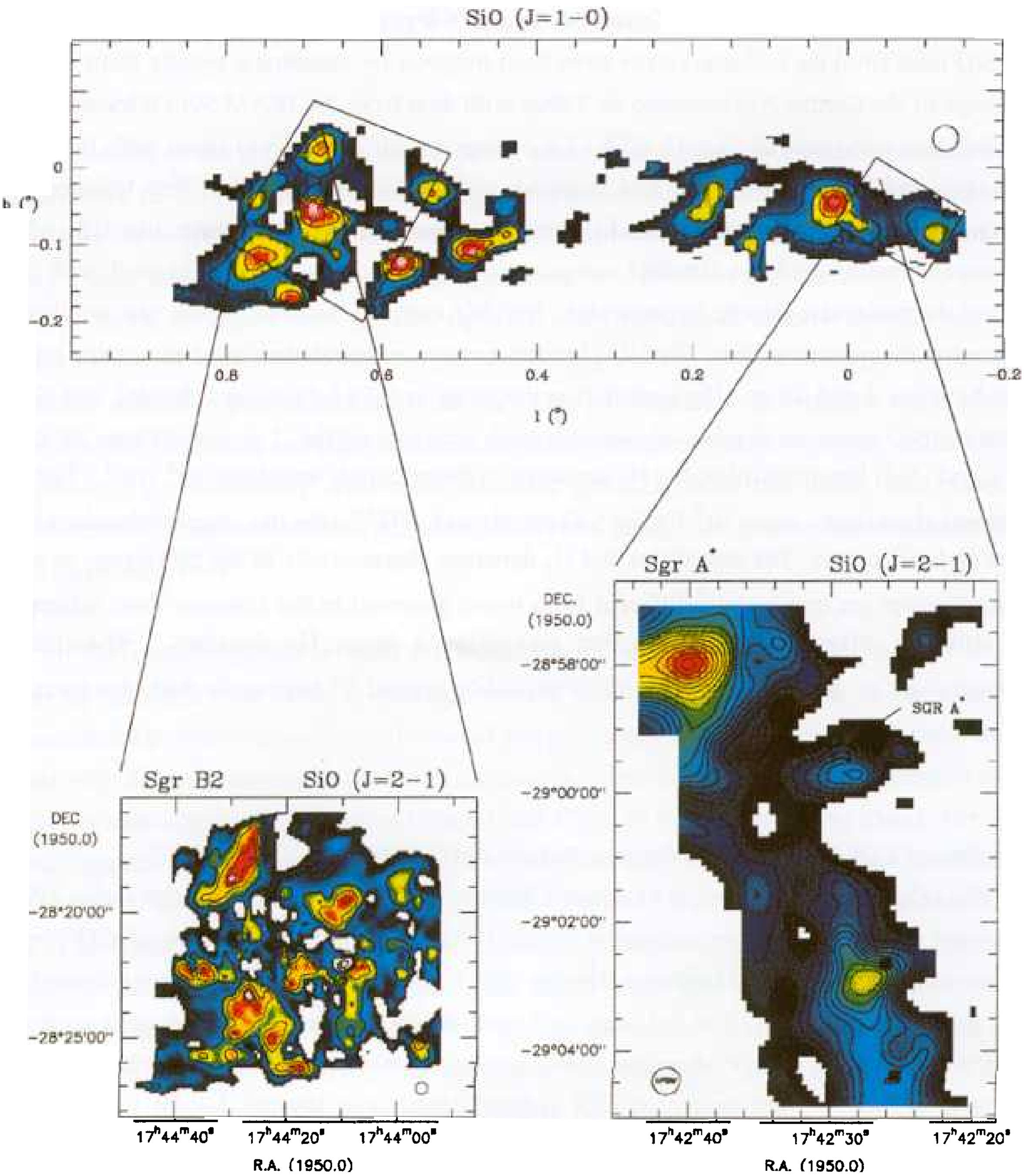


Fig. 2.4 SiO in the Galactic Center. *Upper:* SiO(1-0) emission from the Galactic center clouds, mapped with the 14m Yebes telescope. *Lower left:* SiO(2-1) absorption observed with the IRAM 30m telescope toward the continuum emission from the H II regions in the Sgr B2 cloud. *Lower right:* SiO(2-1) emission in the vicinity of Sgr A, mapped with the 30m telescope. The star indicates the position of the continuum source Sgr A*. The filled squares show the positions of dust continuum peaks at 1.3mm.

2.4 CIRCUMSTELLAR ENVELOPES

A CO (1-0) and (2-1) atlas of circumstellar envelopes of AGB and post-AGB stars

A new ^{12}CO (1-0) and (2-1) survey has been done of a sample of 46 AGB and post-AGB stars. Fully sampled high resolution maps of their ^{12}CO (1-0) emission have been obtained by combining visibilities from the IRAM interferometer with observations from the 30m telescope. Fluxes, radii, and positions of the circumstellar envelopes are derived from model fits to the visibilities and compared with ^{12}CO (2-1) maps made at the 30m telescope. The ^{12}CO (1-0) observations yield mass loss rates for 38 stars and an empirical relation between the CO photodissociation radius of an envelope and the measured radius in the (1-0) emission.

A Thin Molecular Shell around the Carbon Star TT Cyg

Interferometric CO(1-0) and (2-1) observations reveal a remarkably thin shell of molecular gas around the carbon star TT Cyg, with a ratio of width/radius of <1.3"/34" ≈ 0.04 (Fig. 2.4). The shell expands at ≈13 km s^{-1}, and contains ~ 0.02 M_{O} of gas, if the CO abundance relative to H_2 is 10^{-3} and the distance is 1 kpc. The thin shell is spherical, but there are clear deviations from spherical symmetry at the few per cent level. The width of the shell is barely resolved at the arc second level, but there is weak emission extending a few arcsec inward from the rim of the shell. The most likely explanation for the origin of the shell is a drastic change in mass loss properties, possibly combined with the effects of interacting winds.

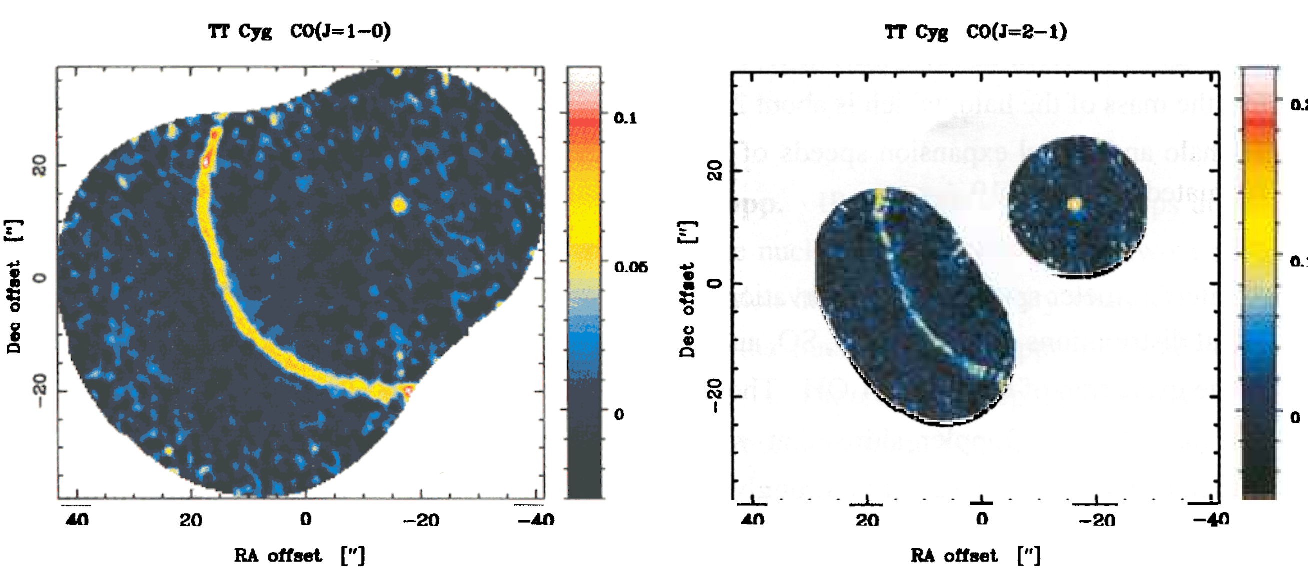


Fig. 2.4 – CO molecules in a thin shell around the star TT Cygni. Interferometer maps of CO(1-0) (left) and CO(2-1) (right). The maps cover about one-quarter of the thin shell, and show also the CO emission from the low-level, present-day mass loss at the star itself.

Pulsar Detection at 87 GHz

Pulsed radio emission at 87 GHz has been detected from the pulsar PSR B0355+54. The observed flux density of 0.5±0.2 mJy is, within the measurement errors, the same as measured previously at 43 GHz and is thus higher than expected. However, the errors are such that all measurements at frequencies higher than 1.2 GHz are consistent with a single power-law spectrum, indicating that the same emission mechanism operates across the whole radio spectrum. A second pulsar, PSR B2021+51, with a reported excess of flux density at 43 GHz, was observed but not detected.

Comet Hale-Bopp

Comet Hale-Bopp, the most spectacular comet of the century, was observed extensively at the IRAM 30m telescope and the IRAM interferometer. Regular maps made with the MPIfR 19-channel bolometer in the continuum at 250 GHz showed the comet to be slightly extended, with a diameter of 11 arcsec. This extent results from a superposition of core and halo components. The IRAM interferometer detected core component, and a model of the flux as a function of interferometer baseline yielded a diameter of 49 km for the radio core. The 11 arcsec size for the halo corresponds to a size of 11000 km at the distance of the comet (typically 1.2 AU during the observations in February 1997). This is about ten times bigger than the halos of comets Halley and Hyakutake. The continuum emission was observed to be roughly constant during the period of the observations, unlike the molecular-line emission, which was highly variable. The submm to mm continuum emission of the comet had a spectral index of 3.2, which corresponds to optically thin emission from a distribution of dust grains ranging in size from about 1 micron to 1 cm. The small dust particles dominate the emission and the mass of the halo, which is about 2 x 10^{13} grams. From the observed 11000 km size of the halo and model expansion speeds of 10 to 100 m/sec, the lifetime of the dust grains is estimated to be 1 to 10 days.

In interferometer spectral line observations, the scientific goals were to study the origins and radial distributions of CO, H_2CO, SO, and HNC in the comet, as well as the radial evolution of the excitation of CO and CH_3OH. The observations show that the SO coma was extended, and that CO had Doppler shifts that were modulated with the period of rotation of the cometary nucleus. These shifts strongly suggest that there was a localized active source of CO outgassing on the nucleus itself. The IRAM 30m telescope provided a wealth of molecular detections that included, in addition to the molecules listed above, SO_2, OCS, CS, H_2S, formic acid (HCOOH), formamide (NH_2CHO), and methyl formate (CH_3CHO). The detected spectral lines indicate that the production rates of these molecules are of the order of 2 to 16 times 10^{28} per second, that is, 0.2 to 3 per cent of the production rate of water molecules.

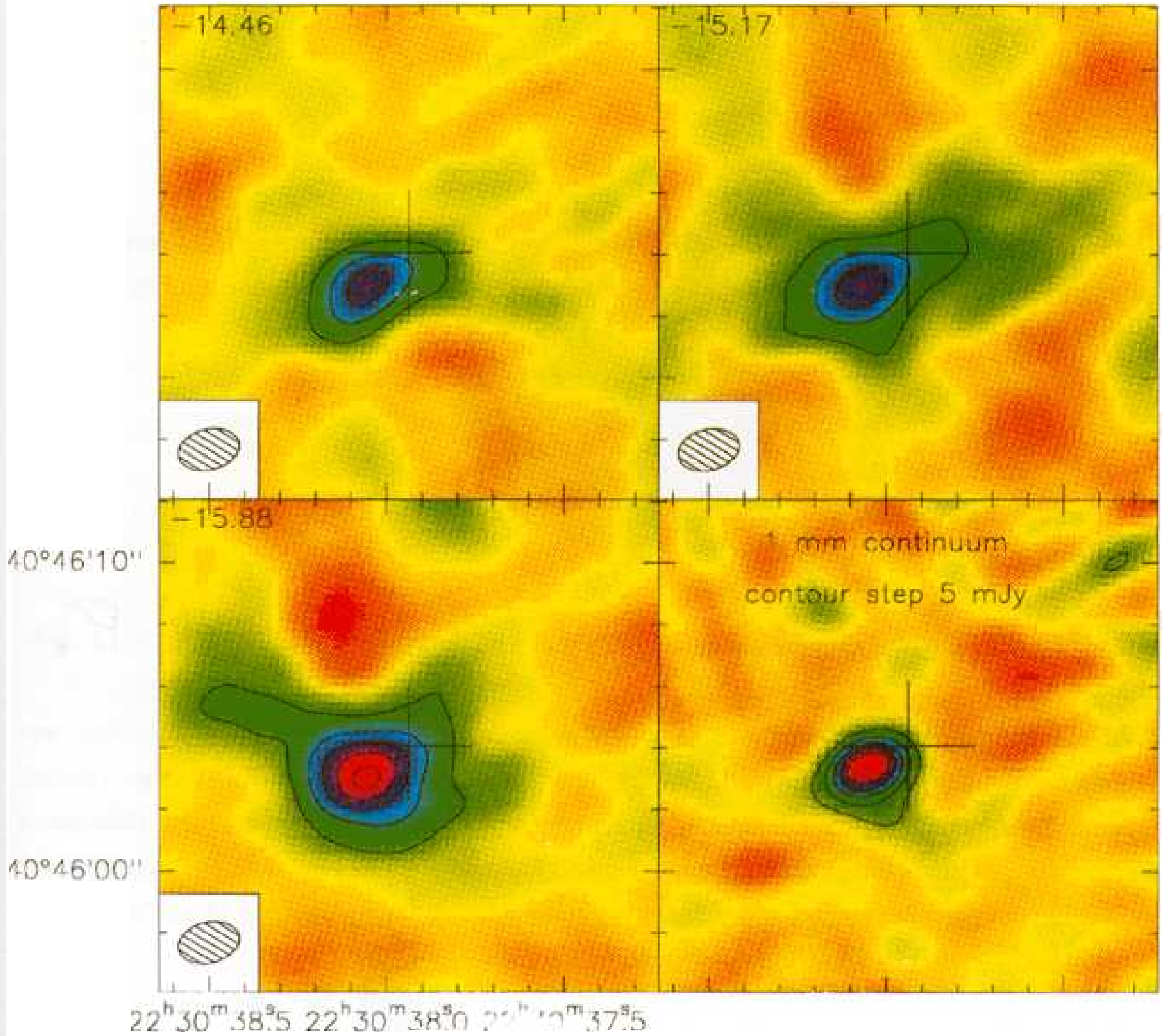


Fig. 2.6 -- Molecules and dust in comet Hale-Bopp. IRAM interferometer maps at 1.3 mm with a 1 arcsec beam of gas and dust around the nucleus of the comet. The two upper panels and the lower left panel show CO(2-1) emission in different velocity channels. The lower right panel shows the dust emission around the nucleus, which appears to be more compact than the gaseous envelope traced in CO(2-1). The contour step is 500 mJy. The cross marks the predicted position according to solution 55 from Yeomans, shifted by +6 arcsec in declination.

3. PICO VELETA OBSERVATORY

3.1 Staff Changes

In the year 1997 there were a number of staff changes, in particular in the astronomers' group. Four astronomers left (1 postdoc, 1 CNRS astronomer, 1 student and 1 cooperant), and two astronomers (1 postdoc and 1 cooperant) joined the group.

In the receiver group, one technician left, and a new cooperant joined the group.

A technician of the backend group left after the completion of a special project for which he had been hired.

3.2 30m Telescope Operation

The operation of the telescope was generally smooth throughout 1997. The telescope was regularly maintained for about 13 hours per week, including receiver filling, receiver maintenance, test tunings, telescope-, computer- and backend-maintenance. In addition, a number of periods of technical time were used for tasks of improving the telescope and observing possibilities, replacing and repairing equipment, doing holography observations, and working on changes in the telescope system.

As in the previous years, a large fraction of the telescope time could be used for astronomical observations (Fig. 3.1). In 1997, two thirds of the total telescope time were used for astronomical observations (including holography and test observations). About one fifth (20.7%) was lost due to bad weather ("stop meteorological") and wind ("stop wind").

Fig. 3.2 shows the use of the telescope time in 1997 in hours. The statistics are based on entries made by the telescope operators.

For the majority of the astronomical projects, we were able to make receiver tunings well in advance of the actual observation. The permanent presence of a receiver engineer at the site helped to provide competent assistance to the visiting astronomers, taking care also of pointing and calibration measurements, as well as service observing for short projects.

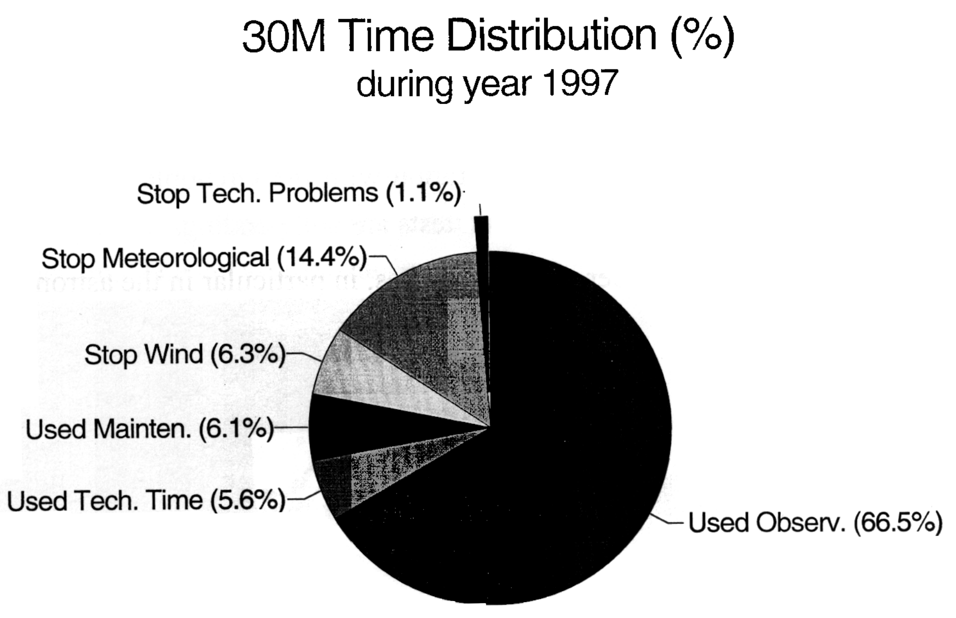


Fig. 3.1: Distribution of telescope time for the year 1997. About two thirds of the total time were used for observations.

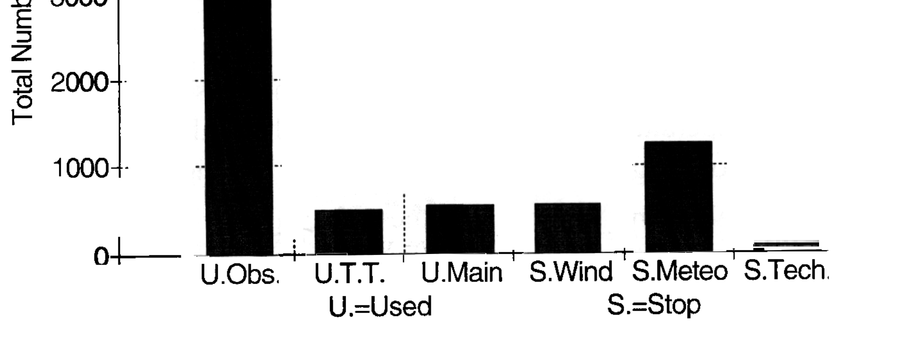


Fig. 3.2: Telescope use during 1997 in number of hours. The loss of telescope time due to technical failures (of more than two hours duration) was 1.1%. Most problems could be solved quickly, also because experienced personnel was at the site.

3.3 Antenna

In order to minimise failures of the wobbler system, a new wobbler control system under VME has been developed (Fig. 3.3) in collaboration with the Grenoble computer group. The project is well advanced, but final and extended tests are still pending.

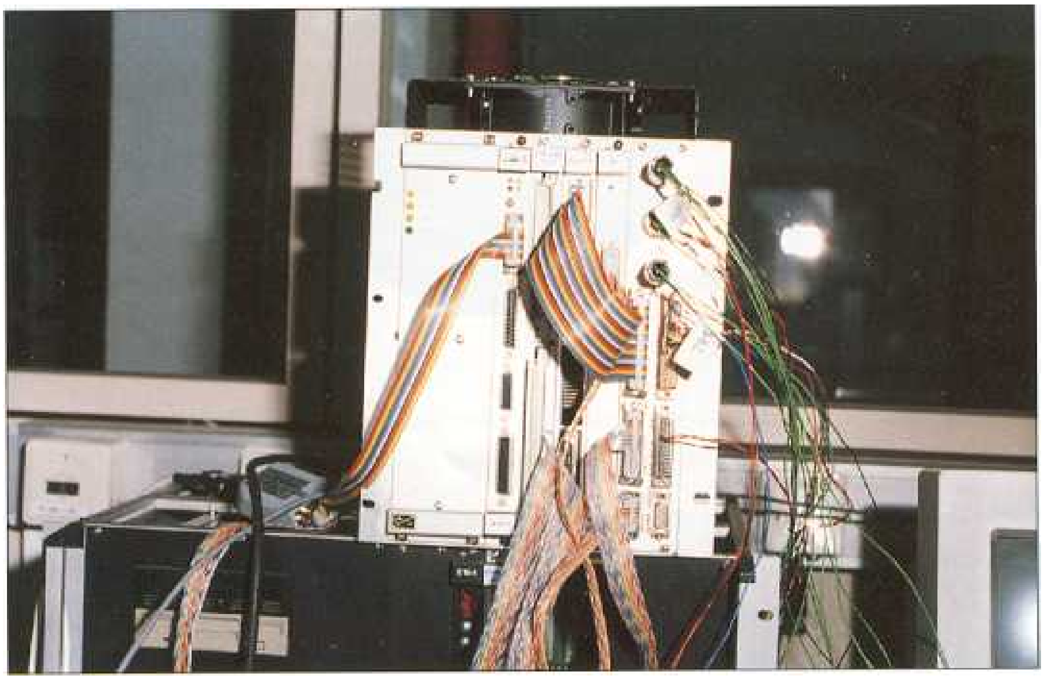


Fig. 3.3: A new VME-based wobbler control system

The cabling interface from the servo system unit to the CAMAC input/output registers has been redone and documented. In addition, the connection has been extended in parallel to the VME input/output register modules and is ready for a future VME antenna control.

More PT100 temperature sensors have been installed. Eight sensors have been placed in a panel frame to monitor temperature gradients and to predict thermal deformations. Six sensors have been installed close to the glycol tubes to monitor the cooling capacity of the system. One sensor has been installed in the air inside the antenna. The installation of another 44 sensors to monitor the temperatures in the yoke is in progress.

The cause for mysterious small focus jumps every 100 seconds which occurred during holography sessions was finally found. The reason was an incorrect reaction to the difference in temperature between the average of the antenna temperature and the reference or master temperature. Now the correction is also applied every 100 seconds, but with an incremental value that is below the resolution of the sub-reflector spindle encoders, but still large enough to closely follow the antenna temperature drifts.

During the bolometer run, at the beginning of the year, large antenna tracking errors and sudden motor control jumps were detected. After carefully checking all relevant hardware components the problem was identified as an overload in the CAMAC serial link.

The deformation of the antenna support structure as a function of elevation was measured with a laser system. The measurements serve to validate the finite element model of the telescope.

3.4 Reflector Surface

In July 1997 a partial adjustment of the surface of the 30m telescope was made. It was based on the holography measurements made in September 1996 and involved 386 screws of the inner five rings of panel frames whose calculated displacement exceeded 25 microns. The outer two rings of panel frames were not moved because of the remaining uncertainty in the interpretation of the holography results at large radii where an unexplained "ripple" in amplitude and phase was observed.

The holography session in September 1997 indicated an improvement in the surface r.m.s. error from 80 microns to 68 microns. These values are axially resolved and amplitude weighted. A correction for systematic effects caused by the measurement errors would give a further reduction to about 65 microns.

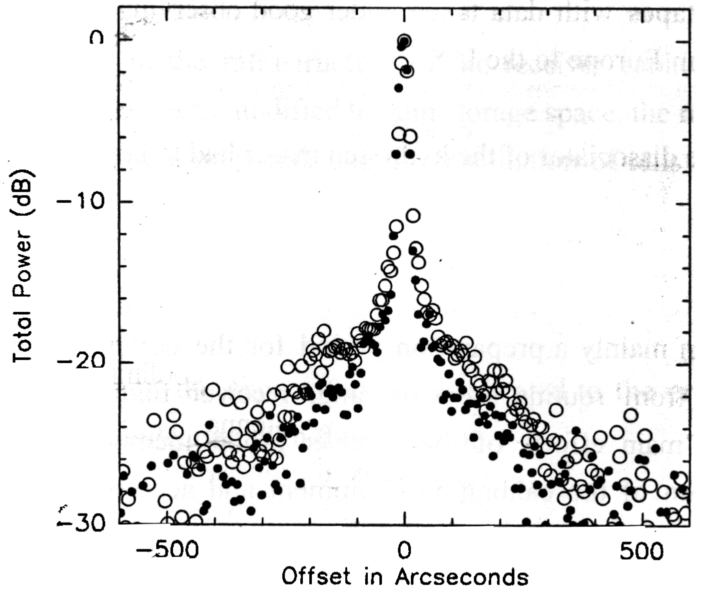


Fig. 3.4 : 30m-telescope beam profile at 2mm wavelength. *Open circles* : data taken before the adjustment of the reflector surface; *filled circles* : data taken after the adjustment.

Four of the panel frames have in the meantime been equipped with additional thermal insulation in an attempt to reduce the temperature gradients due to solar heating during daytime and subsequent nighttime radiation cooling to cold sky. First results suggest a reduction in temperature gradients by a factor of 2 to 3.

The improvement of the reflector surface is confirmed from beam profiles derived from Moon limb scans and from efficiency measurements at 350 GHz. The beam profile shows a reduction of the error beam (as illustrated in Fig. 3.4), the aperture efficiency at 350 GHz increased by ~ 3%, both in agreement with the holography data from September 1997.

3.5 VLBI

The 30m telescope participated at 3 mm wavelength in three global VLBI sessions (April, June, November 1997) with substantial support from the MPIfR. With these three sessions we approach the future goal of two larger sessions (April, October) of approximately 5 days each, and two additional sessions of approximately 3 days each.

In 1997 we observed for the first time simultaneously at LCP and RCP; this mode of observation has since then become a standard. Preparations have started to upgrade the Mk III terminal system. It is the intention to introduce thin tapes early in 1998.

Unfortunately, several tapes with data taken under good observing conditions "annihilated" during the transport from Europe to the U.S.

Due to aging effects, the dissociator of the hydrogen maser had to be changed.

3.6 Receivers

The year 1997 has been mainly a preparation period for the complete refurbishment of the receiver cabin. Apart from routine work (tuning, receiver filling, small repairs, general maintenance etc.), the main efforts of the receiver group members have been orientated towards the construction of the calibration equipment and accessories for the coming dual channel receivers.

Maintenance tasks were nevertheless an important part of the work, probably also due to the general ageing of the existing set of receivers. Just to mention some of the problems encountered during 1997: the mixer of the 230 G2 receiver had to be replaced twice, the 3mm1 mixer backshort drive had to be repaired repeatedly, the 230 G1 cold head had to be replaced, the 2mm Gunn oscillator broke, the beam switching controller and calibration chopper wheel failed.

The optics of the receiver cabin has been improved in several aspects. The dichroic mirror for the 230G2-3mm2 combination has been replaced by a better design that now includes a precision micrometer screw for more reliable adjustments . The old mounting support for the other dichroic mirror (on the 230G1-3mm1 branch) has also been replaced by a precision device that allows the switching to other receivers, like the 350 GHz system, in a reliable way and in a short time. The Nasmyth system has been checked and realigned. A vertex beam alignment system (to make receiver alignments easier and faster) was installed and tested.

The two main projects carried out in the Granada laboratory were the calibration system for the new receiver cabin, and the down-converter box for the future multibeam receiver. First tests on the future closed cycle cold load, using a SC 350 compressor, indicate a physical temperature of 28 K on the absorber metal holder. This temperature is expected to be significantly lower when using the CTI-1020R compressor model.

The transfer of some of the receiver control boards from CAMAC to VME interfaces is continuing. The line injection device is now under VME control. Some new programs (REJECT, ULO, UMIXER) that mainly help the receiver tuning, have been written by members of the receiver group.

Some other modifications in the infrastructure of the receiver cabin were carried out: the ceiling above the access stairs was modified to gain storage space, the room for the compressor for the multibeam receiver was prepared, and the installation of rails for a new bridge crane was completed.

3.7 Backends

Apart from routine activities, the main effort was dedicated to the preparation of the future multi-beam receiver interconnection with the telescope.

The construction of a nine-channel multibeam interface with continuum detectors was completed. Plug-in units were assembled, tested and integrated into a "cable processor" completely dedicated to the multibeam receiver. The device was brought to the telescope and tested there, too. Nine continuum detector channels are ready, along with spare modules. The extension to 18 channels will be straightforward by building more modules. A 18-channel control and display panel has been installed at the control desk of the operator, and works properly.

Foreseeing the need to feed the multi-beam receiver's signals to today's backends, and the ones from today's receivers to the future backends, two cross-connection units were built. Their task is to cross-route the signals of each receiver to the chosen backends with maximum flexibility, under either computer or manual control. Twenty channels can be switched, and an extension to 24 could be contemplated in case of need, by building and inserting a handful of new modules.

For VLBI observations, a dual-channel definitive phase calibrator was built, with remote control, to facilitate dual polarisation VLBI observations. A connection with the meteo station was created to stamp weather information on the VLBI log file.

Investigations were carried out to evaluate the cost and work needed to build filterbanks for the multi-beam receiver. Three technical choices for the filters were examined (helical filters, planar filters and discrete components). Commercial components were purchased and measured. The design of an experimental filterboard has started.

Work began to provide a 100 KHz filterbank with full frequency agility in a GHz I.F. band An architecture was selected, and the preliminary design phase has started.

3.8 Computer and Software

Apart from the daily operation and routine maintenance and upgrades, the computer and software installation has further been improved.

After the installation of a fast and reliable computer link between the Granada office and the 30m telescope in 1996, the link between the Granada Office and the University of Granada (which is the Internet entry point) has been significantly improved in 1997. The leased telephone line was replaced by a 2 Mbit/sec point-to-point (licence-free) radio link. Apart from offering a 32 times higher data rate, the radio link is essentially cost-free, and its investment cost amortised within six months (as compared to the previous telephone cost). The Internet connection from the telescope to our entry point at the University of Granada has now a bandwidth of 2 Mbit/sec. However, the available bandwidth to remote Internet sites is still frequently unsatisfactory due to heavy traffic on the Spanish network.

A work space has been set up at the Granada office for observers who want to use the remote observing mode. Most of the control screens available at the telescope can be transferred to the Granada terminal, and an observer can in principle observe from there.

First tests of remote observing using an ISDN line to Grenoble in addition to an Internet connection have been carried out. The tests have shown that for most of the time the Internet connection is too slow and might not be reliable enough during normal working hours although during off-peak hours its performance may be better. These first tests were very promising, and after a further trial period, remote observing from Grenoble (and possibly other locations) may be opened on a limited basis.

The work space for observers at the telescope has been reorganised. The observer has now a Linux system with a large (20") monitor and a graphical user interface. The observer's input (OBS program) is replicated on the operator's monitor for supervision. This is specially useful for remote observations from Granada and Grenoble. Also, the "quick-look" X-terminal has been replaced, and the SDH program and the RED output is now shown directly on the observer's workstation. In addition, information about positions of planets and other astronomical objects is available and constantly updated by the interactive astronomical ephemeris program XEphem.

Several hardware improvements have been carried out in 1997. Fast-Ethernet interfaces were installed in the two HP workstations at the telescope. Fast-Ethernet is ten times as fast as normal workstations and thus speeds up the data communication between the two workstations. The disk space has been increased to satisfy the "hungry" users (in particular: large disks reserved for on-the-fly- projects and scratch). Disk space has also been increased on the antenna control VAX.

In 1997, the Ethernet cabling at the telescope has been changed from BNC to twisted pair cables (in 1996, it was done at the Granada office), thus increasing reliability. Twisted pair cabling is also needed for Fast-Ethernet, and we are therefore prepared at the MRT as well. In particular, we foresee that normal Ethernet would be too slow to handle data traffic of the new multi-beam receiver if used together with on-the-fly observing modes.

An Ethernet switch has been installed at the telescope which separates the data traffic related to antenna control from other traffic. This improved throughput as well as reliability. Several so-called HUBs for normal and Fast-Ethernet were also installed.

In the Granada office entrance hall, a Meteosat animation with images of the last 6 hours, the last day or last week is displayed. This allows to anticipate possible observing and transport problems due to expected bad weather. The Meteosat animation is also available on the IRAM Granada web pages.
Software for the management of observing project accounts has been developed. It allows to create and delete project accounts, to back-up the project directories to tape and to restore them, with a special treatment for on-the-fly projects and bolometer projects.

The format of the raw-data header files that are written during an observation has been revised. Over the years, the format had been adapted to many changes and improvements. Together with modifications that are needed by the on-the-fly observing mode, we revised the structure of the frontend part of the header files. This also required modifications in the control software. As part of this development, we now have a utility that allows to transform the header files to readable text. The software uses the standard description of the header file (that can be found in our www pages) as a format description and allows to use old versions of this description to look at older header files as well. As the general format of the header files is the same at Effelsberg and the HHT, this software can also be used there.

As in previous years, the computer group participated in technical tests and gave assistance to several special projects and non-standard observing, such as the dual channel PI bolometer "diabolo", holography sessions, frequency switching tests, and the setup of bolometer observations.

3.9 Infrastructure

The electrical installation at the Pico Veleta observatory was partly modified and updated in order to comply with the latest legal requirements and regulations. The certificate of fulfilling the Spanish legal regulations was obtained after a number of modifications (installation of more differential protection switches, isolation of the electrical connection of the UPS output from the mains, installation of ground cables to several parts of equipment, and in particular to the three climatization systems in the antenna and the base tower, installation of larger cross-section cables for the de-icing in accordance with the electrical consumption, reduction of the breaking capacity of several fuse systems, and others).

The hangar for the prime focus platform has been modified (Fig. 3.5). The outside walls have been made higher which allows to keep, during winter time, the subreflector car on the platform, in order to dismount the subreflector in case of problems. Before, it was necessary to remove snow and ice by hand, delaying the work by several hours. Generally, this permits to use the platform in a shorter time because the protective platform fence remains installed, and during winter the snow does not cover the half doors as before.

Fig. 3.5: Work on the hangar for the prime focus platform. The cover doors have been raised to guarantee easier access during winter.

Falling ice had destroyed six Eternit plates from the antenna tower cladding during the bad weather periods in the winter of 1996/1997. They had to be replaced.

The access road to Borreguiles which had been in a very bad condition has finally been paved by the owner, the skiing company Cetursa.

At the end of the year, during a thunderstorm, lightning hit the antenna at the top of the back-structure. As a consequence, part of an outside panel was blown off (cf. Fig. 3.6). It will be repaired in 1998.

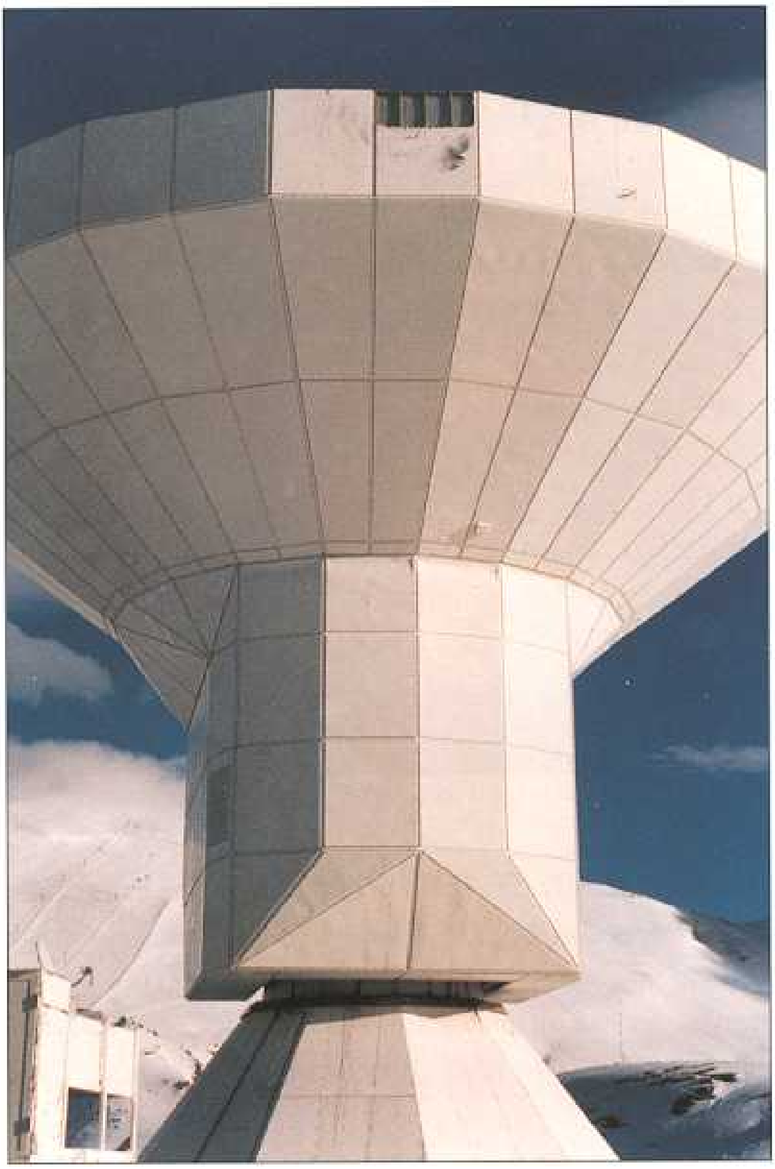


Fig. 3.6: Damage of the cladding of the 30m-telescope caused by a lightning. One of the outside panels was affected by the impact of the lightning.

3.10 Administration - Accomodation - Transport

After 15 years of use and two winters with very bad and harsh weather, the outside of the control building at the telescope site needed some larger maintenance and repair work (Fig. 3.7). Due to the conditions at a high mountain site, special materials and techniques had to be used. The work has been guaranteed for a period of ten years.

Fig. 3.7: The control building during the maintenance and repair work at the outside walls

As in all the years before, the Granada office handled the transport and the accomodation (and many special wishes) of approximately 200 visitors.

4. PLATEAU DE BURE OBSERVATORY

4.1 Interferometer Status

1997 has been one of the very few years where the Plateau de Bure interferometer has not seen major changes such as a new antenna, a new correlator, or a baseline extension. Nevertheless, quite significant improvements have been made:

- *Antenna Electronics*

  The last three antennas (2, 3, 4) have been brought to the same level of component upgrades as antennas 1 and 5: new micro-processors for station changes and transporter control, significant recabling, etc...

- *Antenna Surfaces*

  Antenna 3 has been totally resurfaced. All carbon-fibre panels have been removed, and a new set of machined aluminium panels has been installed. The surface has then been re-adjusted to reach 55 microns r.m.s.

  The surfaces of antennas 1 and 2 have also been re-adjusted, using holography. All antennas now have a surface accuracy better than 60 microns r.m.s., with a typical aperture efficiency of the order of 60% at 230 GHz.

- *Improved Operations*

  The observing modes have been revised and improved. A more sensitive pointing procedure has been installed (a 5-point technique with atmospheric phase compensation based on 230 GHz total power, rather than the previous cross scan method). Pointing and focus measurements have been automated, so that the overall pointing precision of the antennas has been improved to better than 2".

- *Improved Archiving and Calibration System*

  Data are now directly archived on CD-ROM. This results in much easier and faster access to the raw data archive. Pre-calibration is now routinely performed on the site and made available to the guest investigators during the data reduction in Grenoble. Also, the data to be reduced can now be downloaded in advance, thereby saving the time of the visitors who come to Grenoble for data reduction.

The overall improvements in observing efficiency, data quality, pre-calibration and data handling allow in an increasing number of cases the project scientists to start immediately with the imaging step, specially for observations in the 3 mm window.

The interferometer operated with full efficiency in the first half of the year. The combination of smooth operations and exceptional weather conditions in March-April 1997 resulted in an "emergency" call for additional projects, because all scheduled projects for the November 1966 to April 1997 period were completed early. The Program Committee was asked on short notice to identify amongst the newly received projects the most promising ones for immediate execution. Thus a few "summer season" projects could be completed before the official start of the new scheduling period!

The large number of modifications (electronics, surface adjustments, etc...) resulted in a somewhat longer 4-antenna period during the summer and the fall of 1997 than normal, but this had no significant impact on the execution of the accepted proposals. Normal 5-antenna operations were resumed by mid-November for the winter period.

4.2 Infrastructure Improvements

- *A new Shelter for the Snow-Ploughs*

  A separate hall has been built to provide adequate protection for the two snow cleaning machines. They had previously been stored in the same area where the antenna maintenance work is done. This had several drawbacks which have now been overcome.

- *Cable-Car*

  After 15 years of operation, the cable-car has received its first major overhaul during the summer of 1997. Most moving parts have been dismounted, inspected and remounted. The cables and pylons have been thoroughly inspected for corrosion, cracks and general deterioration by magnetometer measurements.

- *Safety Issues*

  Special equipment has been purchased that will start an alarm should an accident occur or a health problem arise with one of the workers in the station or outside on the tracks.

5. GRENOBLE HEADQUARTERS

5.1 SIS GROUP ACTIVITIES

5.1.1 General

The SIS group provides the IRAM facilities with high sensitivity superconducting detector and mixer elements and develops new cryogenic microstructures and devices as sensors for the millimetre and submillimetre wavelength region. Apart from the ongoing production of SIS junctions and the development of new THz detectors, several important decisions were taken in 1997 to improve the infrastructure of the laboratory. These became necessary in order to prepare the laboratory for its future development tasks but also to have better controlled conditions and higher reproducibility for the ongoing junction fabrication process itself.

A new automatic pattern recognition system for the e-beam lithography facility has been installed. This system allows for an efficient exposure of repetitive submicron structures over the entire wafer surface.

To improve the reproducibility and the turnaround time in the Nb trilayer preparation, the laboratory's 'workhorse' sputtersystem ALCATEL SCM450 has been equipped with an automatic process control system.

In order to improve the flexibility and the efficiency for modifying existing mask layouts, and for creating new mask layouts, the editor of the industrial CADENCE© software package has been introduced. This program will also simplify the interaction between IRAM and the mask producing industry.

The most important infrastructure project has been the development of a coherent concept for an improved cleanroom facility at IRAM. The existing cleanroom was built in 1985, at a time when the state of the art of photolithography had not yet reached its current level. The cleanroom therefore no longer corresponded to the technological and ergonomic requirements of today's device fabrication processes. The new cleanroom concept will establish a stable and clean environment, and at the same time largely ameliorate the organisation of the fabrication process.

With this development, the IRAM laboratory will not only have the possibility of improving the device reproducibility and quality but also the option to fabricate new and possibly more complex structures in the near future. The actual re-building of the cleanroom started in December 1997 and will be finished in February 1998.

5.1.2 Junction Fabrication

The delivery of the junctions for receivers on the IRAM telescopes remained the main task of the group.

In addition to standard 100 GHz junctions, a new type of junctions for full height waveguide mixers has been fabricated.

Junctions with a 1 mm^2 surface area for the 230 GHz region have been produced with a single mask step definition. For the masks of this junction production run, a new set of test structures was developed to improve the process control. A few junctions for the 230 GHz range were delivered to DEMIRM.

In response to a request from the IRAM receiver group, considerable effort has been made to reduce the parasitic structure in the I-V-curves of Nb-Al-Alox-Nb SIS junctions just above the gap voltage, a structure which is usually attributed to the proximity effect between the Nb and the Al layer and which might deteriorate the mixer performance. The thickness of the Al layer has been optimised for a given current density with respect to the proximity effect and the leakage current of the junction.

In a different set of experiments it was found that under some circumstances careful thermal annealing of Nb SIS junctions can result in improved junction quality. As the normal resistance of the junction changes during annealing, the trilayer fabrication has to take into account in advance the additional change in current density.

5.1.3 Development of THz Devices

During some years already, IRAM has been actively involved in the development of mixing devices for the THz regime. For an ESA/ESTEC project related to the FIRST mission, the development of SIS mixers for frequencies up to 1.5 THz has been continued. NbN junctions were integrated in reduced-loss Al tuning circuits. Mixer elements on quartz substrates were delivered to the contract partners SRON/RUG and the University of Cologne. Receiver noise temperatures with these devices turned out to be relatively high but Fourier transform spectroscopy measurements indicate that the matching of the tuning circuit was displaced in frequency. A principle limit in the operation of high current density NbN junctions with MgO barrier could result from pinhole induced multiple Andreev reflections as indicated by investigations from RUG (Groningen).

Quasioptical structures with NbN junctions and Al tuning circuits have been fabricated for the first time on silicon substrates. As part of the ESA/ESTEC project, structures for a 1.4 THz mixer design were delivered to the University of Cologne. First mixer experiments are underway.

The development and testing of hot-electron bolometric mixer elements has been continued with new Ph.D. students assigned to this task. Receiver noise temperatures at 810 GHz of better than 900K have been confirmed with an IF cut-off frequency of larger than 2 GHz, performance figures which have not yet been achieved by other groups with such devices. The working principle of the bolometric mixers was also successfully tested with a narrow band signal from a second Gunn-oscillator multiplier combination. Optimisation of the film parameters for higher IF frequencies will be pursued in the future.

5.1.4 Device Fabrication by Visitors

Nb SIS junctions with quasioptical coupling produced by Frank Schaefer from the MPIfR, Bonn in 1996 yielded DSB noise temperatures of 680 K at 810 GHz. From August to December 1997 Frank Schaefer used the IRAM facilities again to prepare quasioptical bolometric mixer chips for 0.85, 1.6 and 2.5 THz.

5.1.5 Conferences

Members from the SIS group were heavily involved in the preparation of the FIRST Symposium on "The Far Infrared and Submillimetre Universe", jointly organised by ESA and IRAM in April 1997, and in the organisation of the 5th International Workshop on Terahertz Electronics, held in Grenoble in September 1997. The meetings clearly showed that the field of millimetre and submillimetre technology is rapidly evolving and that IRAM can and should actively participate in these developments as part of the international community.

5.2 RECEIVER GROUP ACTIVITIES

5.2.1 Receivers on the telescopes

The efforts to further improve the receivers on the telescopes has produced a mixed outcome in 1997: some successes and some setbacks.

Plateau de Bure Interferometer.

In May, the dual-channel receiver on Antenna 1 was replaced with a unit that contains a 1.3mm mixer with improved performance, especially around 245GHz. However, it was soon found that the illumination of the aperture was not correct, and the installation had to be reversed. The receiver was taken back to the laboratory. The optics was successfully modified and tested. However, its re-installation at the telescope was delayed until the end of the winter observing season, the receiver now being in standby.

30-m telescope, 345GHz receiver.

The 345GHz receiver was installed at the telescope for two weeks during the winter period, for the first time with a 1-GHz wide IF centred at 4GHz (fabricated by the Centro Astronomico in Yebes), and the possibility to reject the image frequency, which allows a significant improvement of the system temperature, which is now dominated by atmospheric emission. The receiver performed quite well. The receiver temperature —measured at the cryostat window— was as low as 30K DSB, and 50K SSB with 7dB image rejection (cf. Fig. 5.1).

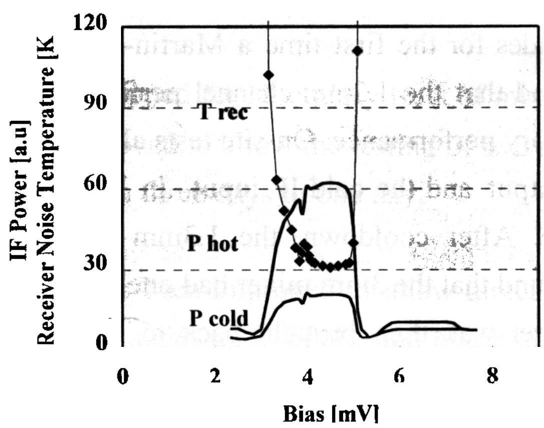


Fig. 5.1 : Double sideband noise of the 345GHz receiver measured at the cryostat window.

Thanks to the good atmospheric conditions, and to the image band rejection, system temperatures of 400K on the T_A^* scale were recorded during astronomical observations as shown in Figs 5.2 and 5.3.

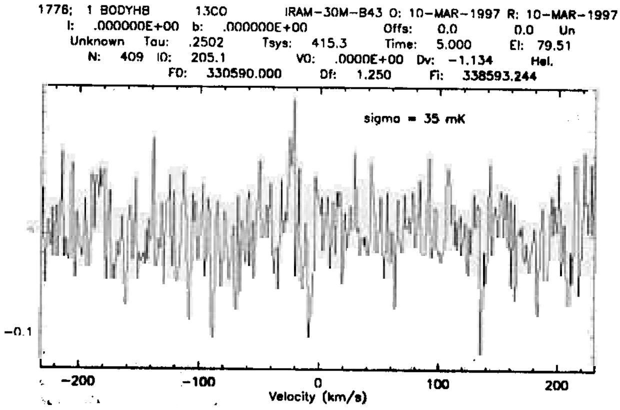


Fig. 5.2 : Under good atmospheric conditions, it was possible to reach a 35mK rms noise with the 345GHz receiver in 5min integration (1.25MHz BW). Data obtained with the kind cooperation of F.Combes.

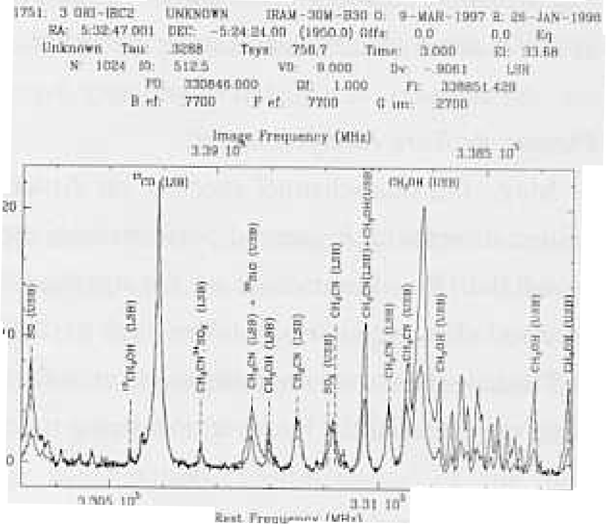


Fig. 5.3 : Test spectra (superimposed) obtained on the Orion molecular peak, to demonstrate the rejection of the image sideband

30-m telescope, prototype dual- channel receiver.

The prototype dual-channel receiver of the new generation was prepared and tested in the laboratory, and was shipped to the telescope in November 1997. That receiver is of the same general design as the current Plateau de Bure receivers, except that it is matched to the f/10 30-m optics, and that it includes for the first time a Martin-Puplett diplexer. After installation and cooldown, it was found that the 1.3mm channel performance had significantly degraded with respect to the laboratory performance. On-site tests allowed us to diagnose an anomalous loss between the mixer output and the cold IF input. In December, all suspect components were replaced on the site. After cooldown, the 1.3mm channel showed close to nominal performance, but it was found that the 3mm mixer had one of the junctions in the series array short-circuited. The receiver was then brought back to Grenoble for repair and extensive testing.

5.2.2 Receivers under construction

Dual-Channel Receivers for Pico Veleta

The four cryostats (totalling five with the prototype, including one spare) foreseen for the refurbishment of the 30-m telescope cabin have been tested and validated for vacuum and cryogenics. Local oscillator boxes were prepared for the new 30-m telescope receivers. Essentially all of the RF components were fabricated by the IRAM workshop. Several mixers were assembled and characterised. Five triplers for the 200-290GHz range, and 2 doublers for the 130-170GHz range were constructed and characterised, and found to meet the system specifications. The prototype Martin-Puplett interferometer for frequency diplexing was constructed; it was interfaced with the cooperation of the computer group and went through RF tests on the antenna range.

Heterodyne Multibeam Receiver

The design of the cryostat for the heterodyne multi-beam receiver was completed and its construction contracted. The K-mirror de-rotator was constructed and tested in co-operation with the computer group. A new type of junction bias circuit, more compact, and interfaced via an I2C bus, was developed and tested. The L.O. system procured from RPG was tested; some modifications were made to allow automatic setting under computer control.

Other Devices

Several quarter-wave plates were fabricated and were used at the 30-m telescope for Zeeman and VLBI experiments.

5.2.3 Laboratory instrumentation

Two new N_2/He cryostats were equipped for laboratory tests of mixers. The 15K cryostat for tests of HEMT amplifiers was improved to allow the testing of two amplifiers in parallel, and to decrease the turnaround time from three days to one day.

The near field antenna test range has been improved to allow direct measurements of the SIS receivers and their optics. Dynamic ranges up to 50dB, and phase accuracies of a few degrees have been obtained up to 250GHz. The system (see Fig.5.4) allows an accurate characterisation of the focal and aperture plane internal alignment of the two channels of a dual –channel receiver. Software has been developed to propagate the near field measurement to the telescope aperture and to the sky, allowing to predict the efficiencies and beam quality.

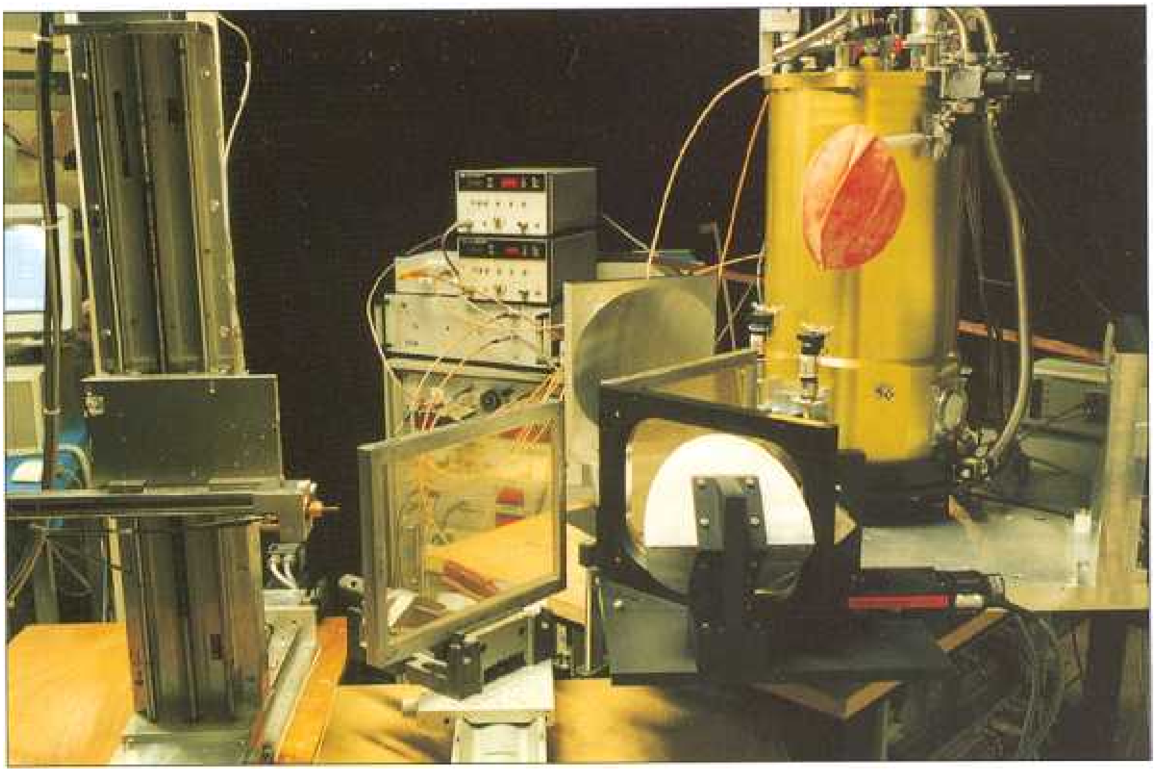


Fig.5.4: A dual-channel receiver, including the quasi-optical diplexer, under test on the near-field antenna range.

5.3 BACKEND DEVELOPMENTS

5.3.1 New Set of Low-Noise LO2's

A series of four "LO2 plug-ins" has been rebuilt in preparation for the 6th antenna of the Plateau de Bure Interferometer. Some difficulty was encountered to find the parts. Although not a very old design (1994), two major suppliers had disappeared from the market in the meanwhile. The new units have improved noise characteristics which significantly affects the interferometer efficiency.

5.3.2 Lab Testing of the CESR Spectrometer

The correlator chip developed in Toulouse has been successfully tested up to a clock speed of 580 MHz. It has been connected together with the IRAM samplers and the Bordeaux IF processor to form a complete wideband spectrometer. Long-term stability tests have successfully been performed. The device was then brought to 30-m telescope on the Pico Veleta for an astronomical test under field conditions. A detailed report, written by H.Wiesemeyer, is available upon request.

5.3.3 Design of the New Correlator for a 6-Antenna Array

♦ *Correlator Chip*

The 64-channel ASIC design has successfully passed the functional simulation on our set of test vectors. The total gate count is 29702. The VHDL edition and simulation runs have been executed by the subcontractor (Misil) in Paris. The routing has been performed at NEC's European design centre in Duesseldorf. The post-routing simulations have indicated excellent timing performance so the decision was taken to go to the foundry. The production of the first 30 prototypes will take place at NEC's facility in Japan.

♦ *Correlator System*

The chassis, racks, power supplies and backplanes for the prototype unit are assembled. The integrated RF assemblies for the IF processing have been designed and the relevant electronics developed. The SSB mixer prototype has demonstrated >28dB rejection over 2 x 200 MHz. The 10-layer correlator board design has started. For some components where the risk exists that they may relatively soon disappear from the market, life stocks have been purchased. These include specialized IC's, mixers, VCO's....

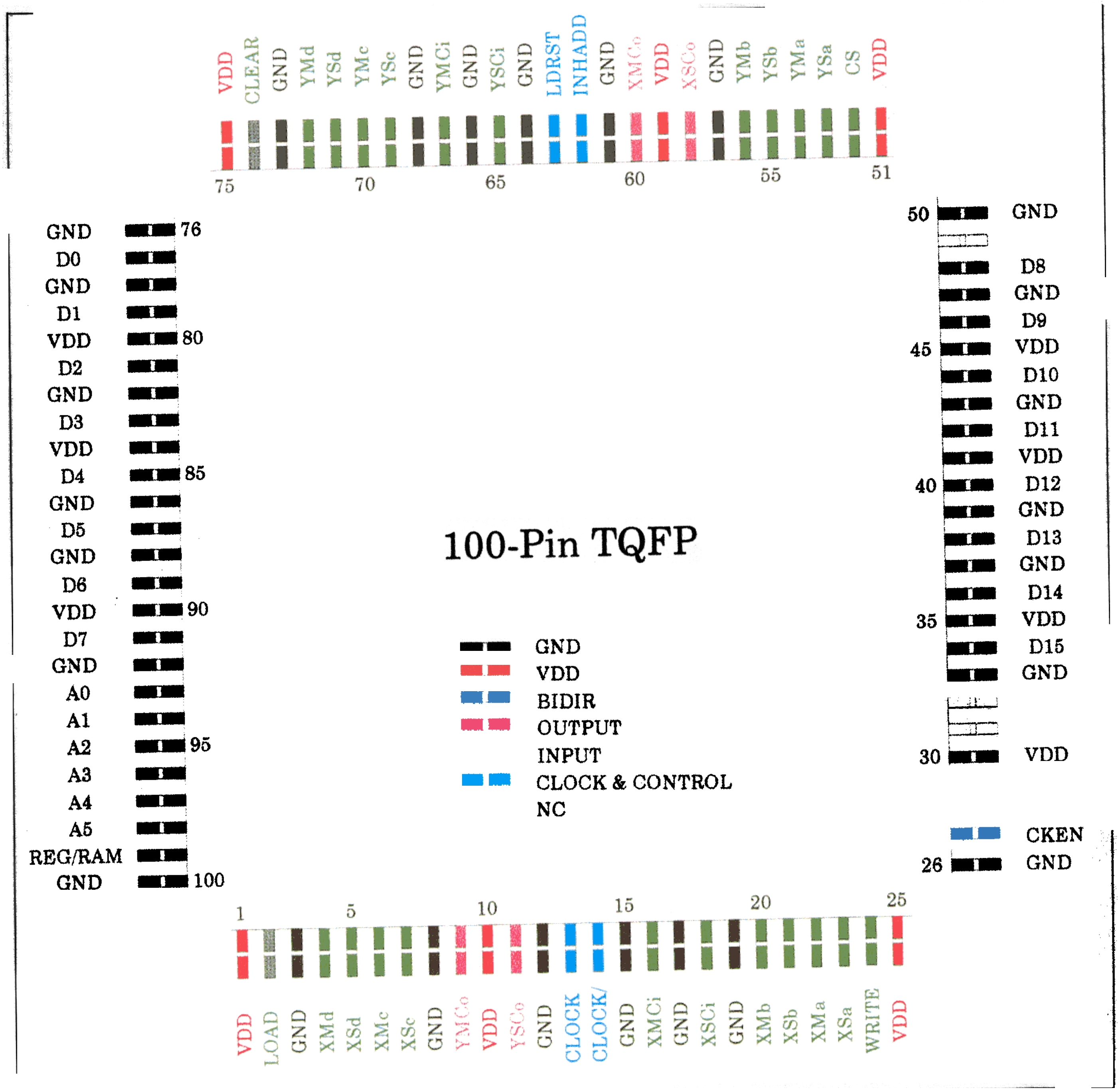


Fig. 5.5 : Pin assignment for the new IRAM correlator chip.

5.4 COMPUTER GROUP

In 1997, the major efforts went into improving the existing facilities and to provide the necessary support to the users. Activities that deserve special mentioning include the:

- development of radiation transfer models on the CRAY super computer using parallel processing
- study of the wavelet functions as a possible tool to improve some noisy results obtained with the NIC package applied to bolometer data
- improvement of the Plateau de Bure correlator data acquisition software
- general (major) system update of all UNIX systems at Grenoble with the installation of a new data reduction work-station
- hardware upgrades of our old 486 PC's by replacing the motherboards and by purchasing new Pentium chips. This procedure has been set up and proved to be economical and reliable.
- first tests of the 30m wobbler VME control which gave encouraging results
- continuous improvements of the receiver software for Plateau de Bure
- inclusion of control hardware and software for Pico Veleta for the Martin-Puplett diplexers
- installation of an ISDN (Numeris in France) line between Grenoble and Granada, and as a consequence the first remote observations
- improvement of our WEB pages with a search engine, counters and plenty of new information thanks to the astronomers
- generalization of the use of CD ROMs to record Plateau de Bure interferometer data.

5.5 TECHNICAL GROUP

5.5.1 Mechanical Workshop

The workload on the staff of the mechanical workshop was extremely high throughout the year 1997. The main task was the fabrication of microwave components for the HDV10 150/300 GHz receivers which will be installed in the cabin of the 30m telescope on Pico Veleta (mixers, compact couplers, horns, lenses, etc.).

In total, the mechanical workshop could satisfy 183 orders, 32 of which were sub-contracted to local manufacturers.

In response to the continuously growing demands, the workshop has invested into :

- a CNC milling machine with a high-speed head,
- three-dimensional precision control equipment (+/- 1 µ) - cf. Fig. 5.6
- a new grinder to make micro-tools,
- a new electronic system for the electro-forming bath (4 heads instead of 3).

These new facilities and enhancements should help to improve the quality of work.

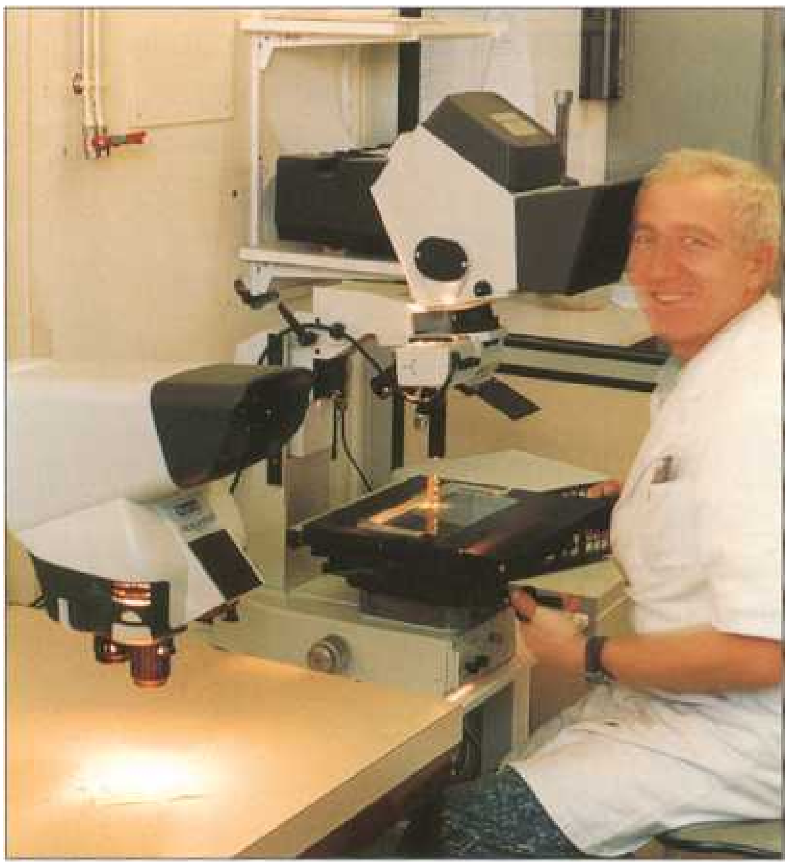


Fig. 5.6 : Quality control of micro-machined components. This device allows measurements with an accuracy of +/- 1 um in xvz.

5.5.2 Drawing Office

The drawing office worked on numerous mechanical designs, in close collaboration with the IRAM staff. The subjects were:

a) the support and mechanical components for the 115/230 GHz prototype receiver for the 30m-telescope on Pico Veleta;

b) the total re-design of the Pico Veleta receiver cabin with a new layout of the optical system. The components studied were :

- the framework support of the 115/230GHz receivers,
- the beam switching mechanisms,
- the installation of mirrors, grids and the Martin-Puplett interferometers,
- the general implantation of all system components (racks, bays, cold loads etc.).

c) the mounting and the calibration of the de-rotator (cf. Fig. 5.7);

Fig. 5.7 : Beam- de-rotator for the new receiver cabin of the 30m-telescope on Pico Veleta.

d) the detailed study of the multi-beam system in preparation of the final construction;

e) the integration of the de-rotator assembly for the multi-beam in the Pico Veleta receiver cabin (cf. Fig. 5.8);

f) the technical design of all microwave components for Pico Veleta or Plateau de Bure.

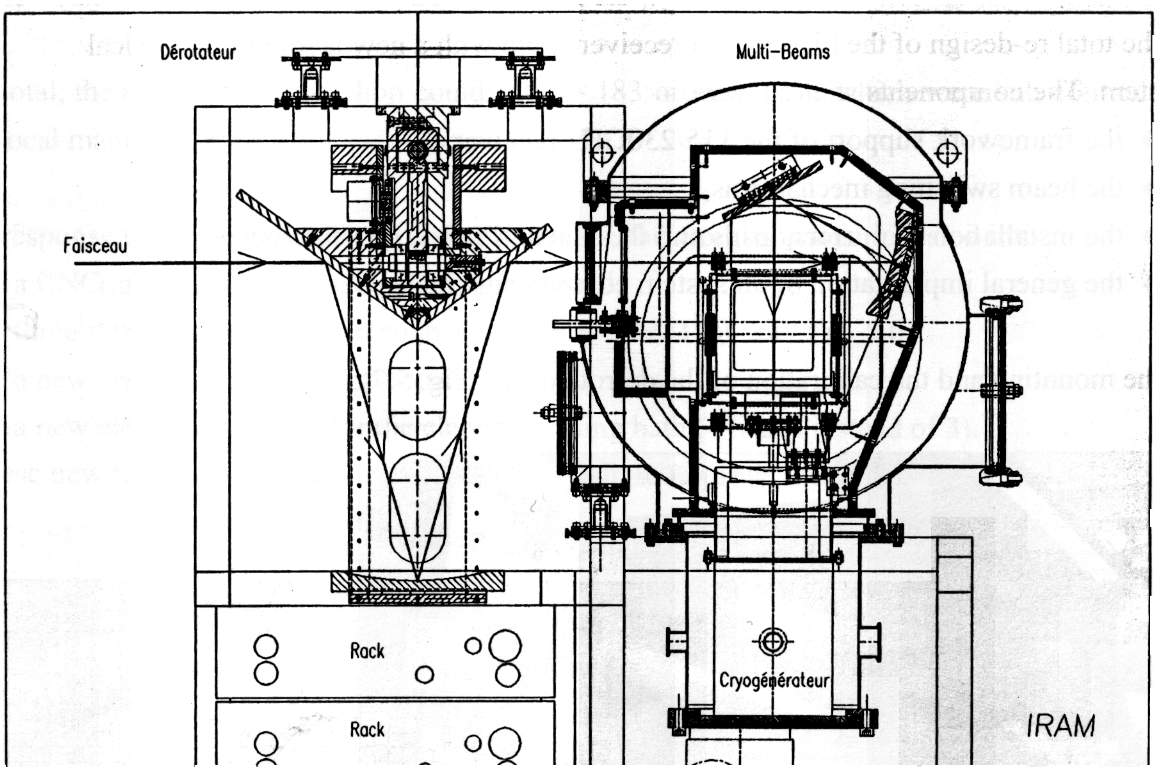


Fig. 5.8 : Design of the support structure for the de-rotator unit belonging to the IRAM multi-beam receiver

5.5.3 Start of the Construction of Antenna 6

IRAM's technical group is responsible for the construction of the mount of Antenna 6. Towards the end of 1997, the first long-lead components (bearings and gears for AZ/EL) were contracted, and the call for tender was prepared for the main structural elements of the mount.

The current timetable for the construction of the 6th antenna for the Plateau de Bure Interferometer is shown in Fig. 5.9.

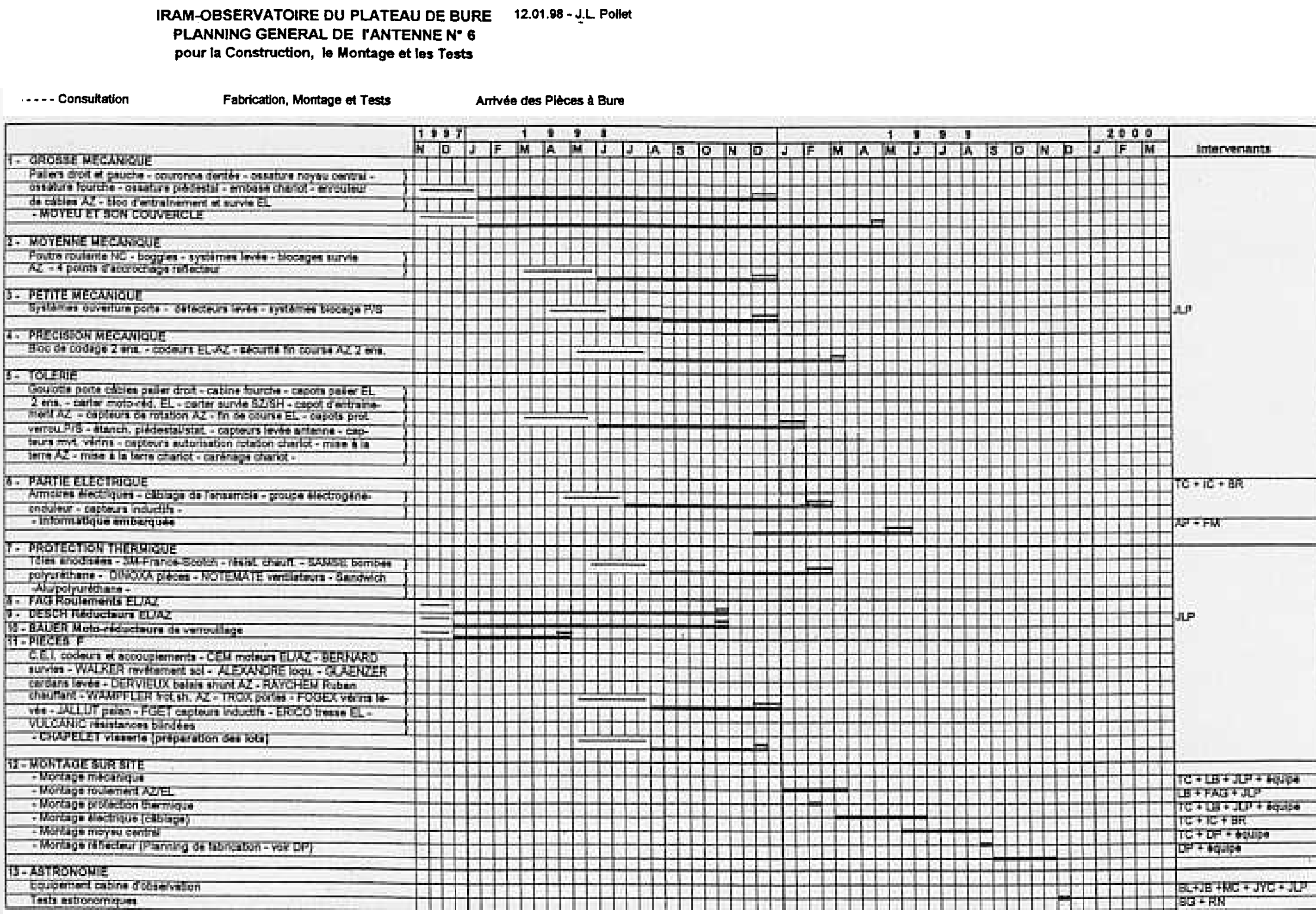


Fig. 5.9 : Schedule for the construction of the 6th antenna for the PdB Interferometer.

5.5.4 Technical Support for the Plateau de Bure

The Technical group has supported, as in previous years, the maintenance work for the existing five antennas in close collaboration with the groups on the Plateau de Bure.

6. PERSONNEL AND FINANCES

In 1997, IRAM had a total of 95,4 (out of 99) staff positions filled. Of these, 69.1 staff positions were allocated in France, and 26.3 in Spain. In addition, 11 PhD students, post-docs and cooperants worked at IRAM, 8 in France, and 3 in Spain. This brings the total number of employees to 106.4. As in earlier years, there was a need to sign short-term contracts to cope with the extra workload during certain periods of the year. This corresponds to 2.5 man-years in Grenoble, and 2 man-years on the Plateau de Bure. The extra work in Grenoble was caused by replacements in the Administration and in technical groups, and on the Plateau de Bure by the maintenance work on antennas 1 – 5, and on the cable-car. The MPIfR, Bonn and the MPI für Extraterrestrische Physik, Garching jointly financed one half of a position in the SIS laboratory. One PhD student in the SIS laboratory was partly funded by the German Ministry BMBF (Verbundforschung), another PhD student was partly funded by the German Science Foundation (DFG) through the University of Würzburg, and a third position by the CNRS.

IRAM's financial situation in 1997 and the budget provisions for 1998 are summarised in the following tables. Expenditures in the operations budget 1997 are slightly higher than the original estimates, especially due to an increase in costs for materials. On the investment side of the budget some underspending occurred. A contributing factor was the delayed delivery of some laboratory equipment. Furthermore, some of the originally foreseen purchases were postponed from 1997 to 1998. The corresponding budget provisions must therefore also be transferred to 1998. Another factor which contributed to the apparent underspending is connected with the construction of the 6th antenna for the Plateau de Bure Interferometer. Following the positive Council decision at the end of June 1997, an amendment text to the CNRS/IGN/MPG agreement had to be prepared and signed by the three agencies. This took more time than foreseen. Only the longest-lead items were therefore contracted before the end of the year.

The major items in the investment budget were: 0.5 MF for minor reconstruction- and new construction works, 0.6 MF for a hall for the snow cleaning machines on the Plateau de Bure, 1.2 MF for the construction of a clean room in the SIS laboratory, 0.4 MF for spare parts for the cable-car, 0.6 MF for receiver and backend instrumentation, 0.6 MF for equipment in the mechanical workshop, and 0.8 MF for computer equipment. For the improvement of antennas 1 - 5 on Plateau de Bure and the 30m telescope on Pico Veleta, and for the construction of the 6th antenna 5.7 MF were spent, 2.8 MF for the construction of new receivers and backends, and 0.3 MF in the area of administration and transport. The income other than contributions from the IRAM partners was lower than foreseen due to lower interest gains, as well as a smaller number of projects funded by other agencies (e.g. ESA, ESO etc.).

B U D G E T 1997
(including actual Antenna 6 funding)

Expenditure

BUDGET HEADING	APPROVED BUDGET KFF	ACTUAL BUDGET KFF
Personnel	41.225	40.875
Operations	14.491	14.908
	55.716	55.783
Investment	29.793	13.830
Value Added Taxes	5.209	5.209
	90.718	**74.822**

Income

BUDGET HEADING	APPROVED BUDGET KFF	ACTUAL BUDGET KFF
Contribution CNRS	30.106	30.200
Contribution MPG	30.106	30.200
Contribution IGN	3.844	3.856
Contribution Antenna 6	6.600	2.200
Other Income	14.853	15.236
Contribution CNRS for Value Added Taxes	5.209	5.209
	90.718	**86.901**

BUDGET PROVISIONS 1998

Expenditure

BUDGET HEADING	APPROVED BUDGET (KFF)
Personnel	42.125
Operations	13.755
	55.880
Investment	16.860
Value Added Taxes	5.265
	78.005

Income

BUDGET HEADING	APPROVED BUDGET (KFF)
Contribution CNRS	30.381
Contribution MPG	30.381
Contribution IGN	3.879
Contribution Antenna 6	6.600
Other Income	1.500
Contribution CNRS for Value Added Taxes	5.264
	78.005

7. ANNEX I : TELESCOPE SCHEDULES / 7.1 IRAM 30m Telescope

Dec 31 - Jan 14

Ident.	Title	Freq. (GHz)	Authors
141.96	Time delay measurements in the gravitational lens PDS 1830-211	94	Combes, Wiklind, Kramer
206.96	Molecular gas in faint blue galaxies at intermediate red shifts	153, 158, 160, 151	Wilson-C, Combes
262.96	The spatial extent and abundance of water vapor in mol. clouds	183, 230, 204	Cernicharo, Gonzalez-Alfonso, Cox
136.96	High density gas in megamaser galaxies	88, 89, 110, 244	Baudry, Baan, Henkel
164.96	CO multi line OTF mapping of the S106 molecular cloud	89, 109, 115	Schneider, Kramer, Simon, Stutzki
205.96	Densities and kinetics temperatures in Orion north	91, 147, 220, 224	Wilson, Gensheimer, Martin-Pintado, de Vicente
229.96	Chemistry of protoplanetary disks IV	113, 145	Dutrey, Guilloteau, Guélin
189.96	Probing the different mol. gas components in the nucleus of IC 342	177, 241, 259, 354	Schulz. Guesten
δ23.96	Search for the primordial molecule LiH in a dense molecular cloud		Combes, Wiklind
141.96	Time-delay measurements in the gravitational lens PDS 1830-211	94	Combes, Wiklind, Kramer
237.96	CO in the halo of the magellanic irregular galaxy NGC 4449	115, 230	Kohle, Henkel, Klein

Jan 14-Jan 28

Ident.	Title	Freq. (GHz)	Authors
189.96	Probing the different mol. gas components in the nucleus of IC 342	117, 241, 259, 354	Schulz, Guesten
141.96	Time-delay measurements in the gravitational lens PDS 1830-211	94	Combes, Wiklind, Kramer
214.96	A deep search for redshifted (NII) 205 micron emission from BR1202-0725	256	Van der Werf, Yun, Scoville
177.96	Fractional ionization in the collapsing starless core L1544	86, 89, 109, 216	Caselli, Myers, Tafalla, Williams, Walmsley, Guélin
δ21.96	OTF CS survey of a galactic center cloud		Kramer
178.96	Complex O-bearing and N-bearing molecules in hot cores	91, 98, 161, 171	Caselli, Cesaroni, Felli, Walmsley

Jan 28-Feb 11

Ident.	Title	Freq. (GHz)	Authors
Guarant. Time			Kreysa
257.96	A 1.3mm search for extremely embedded objects in nearby young clusters	Bolometer	Bachiller, Mardones, Tafalla, Myers
222.96	Cold dust in four giant cloud associations of M33	Bolometer	Guélin, Viallefond, Neininger, Zylka, Mezger
217.96	Cold dust in M51 and M100	Bolometer	Zylka, Guélin, Garcia-Burillo, Neininger, Mezger
239.96	Search for small anisotropy of the cosmic microwave background	Bolometer	Kreysa, Bierman, Chini, Haslam, Zylka
171.96	large scale mapping of the galactic center	Bolometer	Zylka, Mezger, Duschl

Feb 11 - Feb 25

Ident.	Title	Freq. (GHz)	Authors
197.96	Continuum emission in young outflows	Bolometer	Gueth, Neri, Guilloteau, Dutrey, Bachiller
183.96	A systematic study of the environment of Herbig Ae-Be stars	Bolometer	Fuente, Martin-Pintado, Bachiller, Palla, Neri
198.96	Mm emission from dust envelopes around post-AGB stars	Bolometer	Alcolea, Bujarrabal, Contreras, Cernicharo, Cox, Neri
231.96	Dust to gas ratio in the envelope of T-Tau	Bolometer	Schuster, Neri, Russell
226.96	Probing fragmen. in a region of multiple star form.	Bolometer	Andre, Motte, Neri, Abergel, Ward-Thompson
234.96	Mapping the cold dust emission from HI warps	Bolometer	Neininger, Guélin, Dumke, Zylka, Wielebinski
251.96	Dust in a future dwarf galaxy ?	Bolometer	Henkel, Braine, Brouillet
δ02.97	Systematic study of 1.25mm emission of radio quiet QSOs with z¿4		Omont
243.96	Bolometer 1.3mm observation of symbiotic stars	Bolometer	Mikolajewska, Omont, Friedjung

Feb 25 - Mar 11

Ident.	Title	Freq. (GHz)	Authors
200.96	1mm search for primeval quasars or galaxies	Bolometer	Barvainis, Antonucci, Hurt
212.96	Survey for circumstellar disks in cluster environments	Bolometer	Lada-E, Beckwith
163.96	FIR/mm properties of extragalactic radio sources	Bolometer	Fosbury, Andreani, Wehrle, Freudling, Cimatti
187.96	The planets at 350 GHz	345	Greve, Kramer
142.96	Search for ortho-water fundamental transition in a single molecular cloud	108, 225	Combes, Wiklind
δ03.97	Confirmation of tentative detection of H_2C_6 and search for C_5N in IRC+10216		Guélin, Cernicharo
208.96	Tomography of the magnetic field in the disk of MWC349	125, 231	Thum, Morris-D

Mar 11 - Mar 25

Ident.	Title	Freq. (GHz)	Authors
187.96	The planets at 350 GHz	345	Greve, Kramer
155.96	Protoplanetary disks around solar type stars	Bolometer	Kruegel, Chini, Kreysa, Siebenmorgen, Sievers
153.96	HH energy sources, deeply embedded stars and protostellars condensations	Bolometer	Chini, Reipurth, Sievers, Ward-Thompson
δ01.97	QSOs and high z radio galaxies		Chini
169.96	Simult. multifreq. obs of Comet C/1995 01	Bolometer	Altenhoff, Kreysa, Schmidt, et al.
180.96	is there cold dust in the halo of M82 ?	Bolometer	Klein, Wielebinski, Neininger, Reuter
250.96	Dust emission from pre-stellar cores in Bok globules	Bolometer	Launhardt, Henning, Osterloh, Zylka
223.96	Mm dust continuum from the Cepheus-B molecular cloud	Bolometer	Ungerechts, Sievers, Kramer, Wild, Guélin, Neininger, Cernicharo
234.96	Mapping the cold dust emission from HI warps	Bolometer	Neininger, Guélin, Dumke, Zylka, Wielebinski
156.96	Mass determination for proto-planetary disks	Bolometer	Natta, Grinin, Mannings, Testi, Ungerechts

Mar 25 - Apr 8

Ident.	Title	Freq. (GHz)	Authors
168.96	The recent mass loss rate history of highly evolved stars	Bolometer	Groenewegen, van der Veen, Loup, Habing, Omont
223.96	Mm dust continuum from the Cepheus-B molecular cloud	Bolometer	Ungerechts, Sievers, Kramer, Wild, Guélin, Neininger, Cernicharo
169.96	Simult. multifreq. obs of Comet C/1995 01	Bolometer	Altenhoff, Kreysa, Schmidt, et al.
240.96	A thorough radio spectroscopic investigation of comet Hale-Bopp	88, 96, 115, 147	Crovisier, Biver, Bockelee-Morvan et al.
141.96	Time-delay measurements in the gravitational lens PDS 1830-211	94	Combes, Wiklind, Kramer
133.96	CO observations of two red carbon stars in the galactic halo	115, 230	Groenewegen, Oudmaijer
209.96	A study of the Martian atmosphere near aphelion from HDO and CO transitions	115, 143, 225, 251	Encrenaz-Th, Lellouch, Paubert, Gulkis

Apr 8 - Apr 22

Ident.	Title	Freq. (GHz)	Authors
209.96	A study of the Martian atmosphere near aphelion from HDO and CO transitions	115, 143, 225, 251	Encrenaz-Th, Lellouch, Paubert, Gulkis
240.96	A thorough radio spectroscopic investigation of comet Hale-Bopp	88, 96, 115, 147	Crovisier, Biver, Bockelee-Morvan et al.
141.96	Time-delay measurements in the gravitational lens PDS 1830-211	94	Combes, Wiklind, Kramer
VLBI OBS.			IRAM/MPIfR
214.96	A deep search for redshifted (NII) 205 micron emission from BR1202-0725	256	Van der Werf, Yun, Scoville
13.97	GRS 1915+105 : A runaway black hole ?	89, 230	Mirabel, Chaty, Rodriguez
233.96	CN and HCO^+ in the butterfly NGC 2346	89, 226	Bremer, Neri

Apr 22 - May 6

Ident.	Title	Freq. (GHz)	Authors
13.97	GRS 1915+105 : A runaway black hole ?	89, 230	Mirabel, Chaty, Rodriguez
88.96	An absorption line search toward active galactic nuclei		Crosas, Menten
192.96	$^{12}C^{13}CS$ observations of rho Ophiuchus	109, 110, 220, 230	Palla
Bolo (37-ch)			MPIfR

May 6 - May 20

Ident.	Title	Freq. (GHz)	Authors
167.96	CO observations of ultra luminous IR galaxies	91, 100, 206, 212	Raluy, Colina, Planesas
199.96	Structure and kinematics of two prestellar cores in Ophiuchus	86, 109, 144, 147	Andre, Bacmann, Despois, Ward-Thompson
261.96	The spatial extent and abundance of water vapor in molecular clouds	183, 86, 230, 204	Cox, Young, Huggins, Forveille, Bachiller
184.96	A search for interstellar/circumstellar FeC	160, 200, 240	Ziurys, Apponi, Pesch, Guélin
87.97	The post-perihelion evolution of comet Hale-Bopp	88, 90, 96, 220	Crovisier, Biver, Bockelee-Morvan et al.
AOS Test			U Koeln- IRAM
77.97	Confirmation of H_2C_6 and search for C_5N and C_5H_2	84, 86, 89, 230	Guélin, Cernicharo, Travers, Thaddeus
79.97	OTF mapping of M31, the closest spiral galaxy	115, 230	Neininger, Guélin, Lucas, Wielebinski et al.
185.96	Is ethanol in the galactic center molecular clouds ?	90, 142, 234	de Vicente, Martin-Pintado

May 20 - June 3

Ident.	Title	Freq. (GHz)	Authors
184.96	A search for interstellar/circumstellar FeC	160, 200, 240	Ziurys, Apponi, Pesch, Guélin
185.96	Is ethanol in the galactic center molecular clouds ?	90, 142, 234	de Vicente. Martin-Pintado
79.97	OTF mapping of M31, the closest spiral galaxy	115, 230	Neininger, Guélin, Lucas, Wielebinski et al.
87.97	The post-perihelion evolution of comet Hale-Bopp	88, 90, 96, 220	Crovisier, Biver, Bockelee-Morvan et al.
22.97	Time-delay measurements in the gravitational lens PKS1830-211	94	Combes, Wiklind, Kramer,
208.96	Tomography of the magnetic field in the disk of MWC349	125, 231	Thum, Morris-D
δ17.97	Comet HB		
δ17.97	Comet HB		
66.97	Heating of the galactic center GMCs: large scale shocks or intermediate mass stars	86, 90, 130, 145, 217	Martin-Pintado, de Vincente, Wilson, Fuente, Huettemeister, Rodriguez
42.97	Is SiO emission in external galaxies associated to star formation?	86, 130, 216, 217	Martin-Pintado, Garcia-Burillo, Fuente

June 3 - June 17

Ident.	Title	Freq. (GHz)	
66.97		86, 90, 130, 145, 217	
56.97	SiO emission in low velocity outflows from low-luminosity YSOs	86, 130, 217	
9.97	OH emitting protoplanetary nebulae	88, 115, 130, 147, 230	Contrereas, Colomer, Bujjarabal, Alcolea
165.96	CO in the crab nebula	115	Henkel, Gredel
39.97	CO OTF mapping of the S106 molecular cloud	89, 109, 115	Schneider, Kramer, Stutzki, Ungerechts
38.97	Density and velocity struc. of the mol. gas in the Rosette Molecular cloud	109, 115	Schneider, Bertoldi, Williams, Stutzki
87.97	The post-perihelion evolution of comet Hale-Bopp	88, 90, 96, 220	Crovisier, Biver, Bockelee-Morvan et al.
22.97	Time-delay measurements in the gravitational lens PKS1830-211	94	Combes, Wiklind, Kramer,
139.96	Oxygen in molecular clouds	88, 89, 97, 110, 244	Lis, Schilke, Phillips, Keene

June 17 - July 1

Ident.	Title	Freq. (GHz)	Authors
VLBI obs			IRAM/MPIfR
57.97	OTF mapping of the Cepheus-B molecular cloud	109, 110, 115, 220, 230	Ungerechts, Guélin, Sievers, Wild, Kramer, Cernicharo
26.97	IVC135+54 as probe of the ISM between galactic halo and plane	110, 115, 220, 230	Heithausen, Weiss, Mebold
δ19.97			Combes
20.97	Molecular gas in faint blue galaxies as intermediate red shifts	153, 23	C-Wilson, Combes
24.97	Deriving an upper limit to Tcmb at z=0.25	94, 98, 103, 129, 138	Wiklind, Combes
23.97 (cond)	Search for z=3.4 molecular absorption lines	81, 105, 210, 223	Combes, Wiklind

July 1 - July 15

Ident.	Title	Freq. (GHz)	Authors
99.97	Monitoring of Jupiter after the comet SL9 collision	88, 115, 146, 230, 244	Marten, Moreno, Paubert
8.97	Molecul gas in the chemically young galaxy Mrk 109	111, 115	Frayer, Sauvage, Thuan, Seaquist
29.97	CO observations of ultra luminous infrared galaxies		Raluy, Colina, Planesas
100.97	Observation of the HC15N (3-2) line on Titan	88, 115, 220, 258	Marten, Hidayat, Paubert Bezard
δ9.97	Ser. Observation		Israel
T.T.	A.O.S.		Paubert
22.97	Time-delay measurements in the gravitational lens PKS1830-211	94	Combes, Wiklind, Kramer,
40.97	Ancient planetary nebulae in interaction with the interstellar medium	115, 230	Bujarrabal, Contreras, Colomer, Alcolea
58.97	SiO masers from extragalactic evolved stars		Alcolea, Bujarrabal, Colomer, Zijltra

July 15 - July 29

Ident.	Title	Freq. (GHz)	Authors
86.97	Triggered star form, in mass, photoevap. clumps: C34S and C18S study of NGC281 mol. cloud	109, 219, 96, 144, 241	Wilson, Megeath
3.97	Densities and kinetic temperatures in Orion North: Struct. and Chem. of a radical center	91, 112, 147, 220	Wilson, Gensheimer, Martin-Pintado, de Vincente
4.97	Depletion in molecular clouds: Mapping H2CO in NGC2024	225, 216, 217	Wilson, Wink, Gensheimer, Mauersberger, Walmsley
5.97	A new type of interstellar maser	91, 147, 220	Wilson, Gensheimer, Martin-Pintado, de Vincente
6.97	Physics and chemistry of a newly discovered molecular core in the SgrB2 region	91, 112, 147, 220	Wilson, Gensheimer, Martin-Pintado, de Vincente
22.97	Time-delay measurements in the gravitational lens PKS1830-211	94	Combes, Wiklind, Kramer,
59.97	Probing the nuclear molecular gas in the Seyfert 1 NGC 3227	88, 97, 109, 114, 229	Schinnerer, Eckart, Tacconi, Tacconi-Garman
80.97	A study of the Trifid nebula at optical, infrared and radio wavelengths	115, 89, 130, 144, 93	Cernicharo, Lefloch, Gonzalez-Alphonso, Cox
74.97	A molecular survey of CRL618: from mm waves to the near infrared	82. 105	Cernicharo, Guélin, Cox, Maillard, Moutou, Neri

July 29 - Aug 12

Ident.	Title	Freq. (GHz)	Authors
44.97	IC1396E revisited - an excitation study using C170	112, 109, 224, 219, 96	Klein, Guesten, Stark, Zylka
22.97	Time-delay measurements in the gravitational lens PKS1830-211	94	Combes, Wiklind, Kramer,
61.97	Dust and gas in IC5146: depletion of CO in a cold quiescent core ?	85, 112, 222, 224	Kramer, Walmsley, Ungerechts, Sievers, C-Lada, E-Lada
87.97	The post-perihelion evolution of comet Hale-Bopp	88, 90, 96, 220	Crovisier, Biver, Bockelee-Morvan et al.
67.97	The physical conditions in the core and in the bow shocks of CepE	89, 96, 102, 138, 145	Lefloch, Lazareff, Eisloeffel
81.97	Is the annihilator 1E1740 associated with a molecular cloud ?	89, 113, 226	Lefloch, Duchouroux, Henry
16.97	Chemical bistability in dark clouds: the diagnostic of deuterium fractionation	89, 90, 109, 152, 219	Gerin, Falgarone, Roueff, Le Bourlot, Pineau des Forets, Irvine
71.97	Selective search for mol. species tracing the role of grains in cold mol. cloud chemistry	86, 102, 145, 218, 244	Dartois, Boulanger, Gerin, d Hendecourt, Pineau des Forets

Aug 12 - Aug 26

Ident.	Title	Freq. (GHz)	Authors
32.97	The chemical signatures of the dissipative structures of molecular clouds turbulence	89, 88, 87, 174, 267	Falgarone, Joulain, Puget, Panis, Pineau des Forets
33.97	Dense core form: the small-scale struct. of the env. of low-mass dense core	96, 147, 244	Falgarone, Gerin, Panis, Perrault
12.97	OTF spectroscopy to study the kinematics of the central galaxy	98, 219, 220	Zylka, Guesten, Ungerechts, Duschl
73.97	Depletion of sulfur-bearing molecules in low-mass cores	86, 93, 96, 97, 244, 260	Tafalla, Bergin, Plume, Myers
83.97	An unusual cluster of mm-continuum sources in Cepheus	115, 213	Tafalla, Bachiller, Mardones, Myers
17.97	Complex molecules keystones for understanding hot core excitation	98, 104, 11, 147, 173	Caselli, Cesaroni, Felli, Walmsley, Schilke, Wyrowski
18.97	Fractional ionization in the collapsing starless core L1544	86, 109, 144, 216, 85	Caselli, Myers, Tafalla, Williams, Guélin
19.97	Sequential massive star formation in G35.20-1.74: effects on the parent mol.cloud	97, 146, 244, 102, 222	Caselli, Felli, Testi
22.97	Time-delay measurements in the gravitational lens PKS1830-211	94	Combes, Wiklind, Kramer,
T.T.	Freq.Switch		Thum et al.

Aug 26 - Sept 9

Ident.	Title	Freq. (GHz)	Authors
17.97	Complex molecules keystones for understanding hot core excitation	98, 104, 11, 147, 173	Caselli, Cesaroni, Felli, Walmsley, Schilke, Wyrowski
18.97	Fractional ionization in the collapsing starless core L1544	86, 109, 144, 216, 85	Caselli, Myers, Tafalla, Williams, Guélin
19.97	Sequential massive star formation in G35.20-1.74: effects on the parent mol.cloud	97, 146, 244, 102, 222	Caselli, Felli, Testi
22.97	Time-delay measurements in the gravitational lens PKS1830-211	94	Combes, Wiklind, Kramer
87.97	The post-perihelion evolution of comet Hale-Bopp	88, 90, 96, 220	Crovisier, Biver, Bockelee-Morvan et al.
55.97	The physics of the NGC1333/IRAS2 eastern and western shocks	86, 109, 130, 147, 220	Castets, Lefloch, Langer
48.97	CO in the halo of magellanic irregular galaxy NGC 4449	115, 230	Khole, Henkel, Klein, Greve
30.97	Molecular gas in bipolar planetary nebulae	115, 230	Manchado, Guerrero, Bachiller
11.97	The chemistry of sulfur in star-forming regions	86, 138, 219, 168, 244	Codella, Bachiller
94.97	Distribution of SiO jets in star forming regions	86	Gueth, Dutrey, Guilloteau, Ungerechts
68.97	Stellar SiO masers in the galactic bulge	86, 212	Levine, Omont, M-Morris, Price, Menten
36 - (Serv. Obs.)	CO observations of UV Aur	115, 230	Jura, Kahane (Serv. Obs.)

Sept 9 - Sept 23

Ident.	Title	Freq. (GHz)	Authors
	Distribution of SiO jets in star forming regions	86	Gueth, Dutrey, Guilloteau, Ungerechts
87.97	The post-perihelion evolution of comet Hale-Bopp	88, 90, 96, 220	Crovisier, Biver, Bockelee-Morvan et al.
68.97	Stellar SiO masers in the galactic bulge	86. 212	Levine, Omont, M-Morris, Price, Menten
49.97	Massive carbon stars with high expansion velocity: a new class of carbon stars ?	115, 110, 220, 230, 90	Fuente, Cernicharo
65.97	The latest stages of the evolution of a bipolar outflow: NGC7023 (Follow-up)	110, 146, 230	Fuenet, Martin-Pintado, Cernicharo, Rogers, Rodriguez-Franco
62.97	The origin of the mono polar high velocity gas in Orion A	86, 90, 99, 129, 217, 220	Rodrigez-Franco, Martin-Pintado, Fuente
34.97	Excitation of a molecular cloud by the W44 supernova	98, 147, 244, 230	Reach, Rho
69.97	Nature and kinematics of a bolometer-discovered protostellar clump	86, 109, 144, 219, 230	Andre, Motte, Bacmann, Despois
T.T.	Holography		IRAM Staff

Sept 23 - Oct 7

Ident.	Title	Freq. (GHz)	Authors
T.T.	Holography		IRAM Staff
98.97	The dynamical behaviour of infrared carbon stars	88, 130, 230	Groenewegen, Omont, Habing, Sevenster
91.97	CO emission at the owl nebula's rim	88, 115, 230	Bremer
97.97	M17-North: Molecular line observations of a proto-stellar core	86, 98, 147, 219, 230	R-Klein, Launhardt, Henning
64.97	12 CO(2-1) OTF map of HST field of the Helix nebula	115, 230	Cox, Forveille, Young, Huggins, Bachiller, Lefloch, Lucas, Tielens
96.97	OTF mapping of the isolated star forming cloud NGC1788	110, 115, 220, 230	Sterzik, Dougados, Lefloch, Schuster
52.97	A CO map of the double-barred galaxy NGC5850	114, 228	Leon, Combes, Friedli
22.97	Time-delay measurements in the gravitational lens PKS1830-211	94	Combes, Wiklind, Kramer

Oct 7 - Oct 21

Ident.	Title	Freq. (GHz)	Authors
96.97	OTF mapping of the isolated star forming cloud NGC1788	110, 115, 220, 230	Sterzik, Dougados, Lefloch, Schuster
52.97	A CO map of the double-barred galaxy NGC5850	114, 228	Leon, Combes, Friedli
64.97	12 CO(2-1) OTF map of HST field of the Helix nebula	115, 230	Cox, Forveille, Young, Huggins, Bachiller, Lefloch, Lucas, Tielens
31.97	An HCO^+, CS, and 13CO study of high mass protostellar candidates	86, 98, 144, 219, 220	Cesaroni, Molinari, Brand, Palla
46.97	Observations of HCS^+ and c-C3H2 in NGC253 and M82	85, 82	Oike, Kawaguchi, Nakai, Takano
47.97	Molecular gas in Elephant trunks of M16 - OTF maps	98, 110, 220	Ungerechts, Sievers, Wild, Kramer
11.97	The chemistry of sulfur in star-forming regions	86, 138, 219, 168, 244	Codella, Bachiller
22.97	Time-delay measurements in the gravitational lens PKS1830-211	94	Combes, Wiklind, Kramer
98.97	The dynamical behaviour of infrared carbon stars	88, 130, 230	Groenewegen, Omont, Habing, Sevenster

Oct 21 - November 4

Ident.	Title	Freq. (GHz)	Authors
98.97	The dynamical behaviour of infrared carbon stars	88, 130, 230	Groenewegen, Omont, Habing, Sevenster
76.97	Chemistry of protoplanetary disks: V	87, 113, 140, 145, 210	Dutrey, Guilloteau, Guélin, Richer
VLBI			IRAM/MPIfR
T.T.	Beam Sq.		IRAM Staff
T.T.	Freq. Switch		IRAM Staff
δ23.97			Castets et al.
43.97	CN Zeeman observations: Magnetic fields in molecular clouds	113	Crutcher, Troland, Lazareff, Kazes

Oct 21 - November 4

Ident.	Title	Freq. (GHz)	Authors
δ23.97			Castets et al.
13.97	GRS 1915+105 : A runaway black hole ?	89, 230	Mirabel, Chaty, Rodriguez
76.97	Chemistry of protoplanetary disks: V	87, 113, 140, 145, 210	Dutrey, Guilloteau, Guélin, Richer
77.97	Confirmation of H_2C_6 and search for C_5N and C_5H_2	84, 86, 89, 230	Guélin, Cernicharo, Travers, Thaddeus
79.97	OTF mapping of M31, the closest spiral galaxy	115, 230	Neininger, Guélin, Lucas, Wielebinski et al.
74.97	A molecular survey of CRL618: from mm waves to the near infrared	82, 105	Cernicharo, Guélin, Cox, Maillard, Moutou, Neri
78.97	Missing spacings correction for interferometer maps of M82	110, 115, 220, 230	Neininger, Klein, Schilke
66.97	Heating of the galactic center GMCs: large scale shocks or intermediate mass stars	86, 90, 130, 145, 217	Martin-Pintado, de Vincente, Wilson, Fuente, Huettemeister, Rodriguez
82.97	How "coherent" are dense cores ?	93, 112, 144, 216, 224	Goodman, Caselli, Heyer, Wilner, Arce
63.97	Circumstellar carbon monoxyde around two key stellar objects	115, 110, 230, 220	M-Morris, Forveille, Barnbaum
149.97	Completion of a deep survey of SiO in star-forming regions	86, 130, 217	Codella, Bachiller, Reipurth

November 4 - Nov 18

Ident.	Title	Freq. (GHz)	Authors
δ23.97			Castets et al.
13.97	GRS 1915+105 : A runaway black hole ?	89, 230	Mirabel, Chaty, Rodriguez
76.97	Chemistry of protoplanetary disks: V	87, 113, 140, 145, 210	Dutrey, Guilloteau, Guélin, Richer
77.97	Confirmation of H_2C_6 and search for C_5N and C_5H_2	84, 86, 89, 230	Guélin, Cernicharo, Travers, Thaddeus
79.97	OTF mapping of M31, the closest spiral galaxy	115, 230	Neininger, Guélin, Lucas, Wielebinski et al.
74.97	A molecular survey of CRL618: from mm waves to the near infrared	82, 105	Cernicharo, Guélin, Cox, Maillard, Moutou, Neri
78.97	Missing spacings correction for interferometer maps of M82	110, 115, 220, 230	Neininger, Klein, Schilke
66.97	Heating of the galactic center GMCs: large scale shocks or intermediate mass stars	86, 90, 130, 145, 217	Martin-Pintado, de Vincente, Wilson, Fuente, Huettemeister, Rodriguez
82.97	How "coherent" are dense cores ?	93, 112, 144, 216, 224	Goodman, Caselli, Heyer, Wilner, Arce
63.97	Circumstellar carbon monoxyde around two key stellar objects	115, 110, 230, 220	M.Morris, Forveille, Barnbaum
149.97	Completion of a deep survey of SiO in star-forming regions	86, 130, 217	Codella, Bachiller, Reipurth

November 18 - Dec 2

Ident.	Title	Freq. (GHz)	Authors
149.97	Completion of a deep survey of SiO in star-forming regions	86, 130, 217	Codella, Bachiller, Reipurth
157.97	Spectroscopic study of recently discovered intermediate mass protostars candidates	86, 89, 144, 216, 267	Fuente, Martin-Pintado, Bachiller, Palla, Neri
Moon			Greve
118.97	Search for a new molecule in Titan's atmosphere: HC5N	109, 143, 218	Marten, Hidayat, Moreno, Paubert, Bezard
150.97	CO in long-lived circumstellar disks	115, 230	Jura, Kahane
154.97	Isotopic ratios of heavy elements in evolved stars	89, 144, 157, 163, 170	Kahane, Forestini, Guélin, Cernicharo
137.97	Large-scale lobes in the Micro quasar GRS 1915+105	89, 230	Mirabel, Chaty, Rodriguez
δ25.97			Castets et al.

Dec 2 - Dec 16

Ident.	Title	Freq. (GHz)	Authors
137.97	Large-scale lobes in the Micro quasar GRS 1915+105	89, 230	Mirabel, Chaty, Rodriguez
δ25.97			Castets et al.
192.97	Mapping decrements in teh cosmic microwave background at 1.2 and 2.1mm with Diabolo	Bolometer	Desert, Aghanim, Bernard, Delabrouille, Lamarre, Pajot, Puget, Giard, Serra
193.97	Observations of the hot gas in clusters of galaxies with Diabolo through the Sunyaev-Zel'dovich effect	Bolometer	Desert, Bernard, Delabrouille, Lamarre, Pajot, Puget, Giard, Gaertner, Serra
195.97	Investigating the gas properties in protoplanetary disks of intermediate mass stars	89, 88, 97, 113, 146, 226	Wiesemeyer, Dutrey, Guélin, Guilloteau
175.97	Searching for molecular absorption lines in new gravitation lenses	111, 108, 87, 144, 223	Xanthopoulos, Polatidis, Browne, Wiklind, Combes
122.97	Search for new high red shift molecular absorption line systems	106, 111, 207, 218, 87	Combes, Wiklind
123.97	Search for the primordial molecule LiH in a dense molecular cloud	85	Combes, Wiklind

Dec 16 - Dec 30

Ident.	Title	Freq. (GHz)	Authors
122.97	Search for new high red shift molecular absorption line systems	106, 111, 207, 218, 87	Combes, Wiklind
123.97	Search for the primordial molecule LiH in a dense molecular cloud	85	Combes, Wiklind
213.97	The darkest clouds in the galaxy: follow-up of ISO discoveries	220, 219, 109, 97	Perault, Omont, Hennebelle, Ungerechts, Teyssier
171.97	The spatial extent and abundance of water vapor in molecular clouds	183, 86, 230, 80, 204	Cernicharo, Gonzalez-Alfonso, Cox, Lefloch
187.97	AINC in IRC+10216	143, 155, 215, 227	Guélin, Ziurys, Apponi, Cernicharo
75.97	Search for C_2HD^+ in dark clouds: a molecular ion related to acetylene	85, 135, 243, 87, 144, 262	Gerin, Cernicharo, Cox
214.97	Mapping of a active barred galaxy: NGC 6951	114	Leon, Combes, Friedli
203.97	A search for extragalactic 183 GHz water masers near OH megamaser activity	170, 175, 180, 80, 83	Lonsdale, Doeleman, Barvainis

7. ANNEX I : TELESCOPE SCHEDULES / 7.2 PdB Interferometer

Ident.		Line	Authors
G037	Molecular gas in the merger remnant NGC3921: distribution and dynamics	$^{12}CO(1-0)$ $^{12}CO(2-1)$	F.Casoli M.Gérin M.G.Angonin-Willaime
G043	Radio Photospheres of Mira Variables and the Absolute Flux Density Scale	Cont 1mm SiO(2-1)	M.Reid K.Menten
G044	Hot Clumps in the Orion Bar	$^{12}CO(2-1)$ $^{12}CO(1-0)$	P.Schilke D.C.Lis J.Keene T.G.Phillips
G045	$^{12}CO(3-2)$, $^{12}CO(6-5)$, and 1mm Continuum in IRAS F10214+4724	$^{12}CO(6-5)$ $^{12}CO(3-2)$	D.Downes, P.Solomon S.Radford
G048	Formaldehyde Absorption at z = 0.685 toward the Einstein Ring B0218+357	$H_2CO(2-1)$	K.Menten M.Reid C.L.Carilli C.M.Walmsley
G049	The massive ^{12}COunter-rotating gas disk of NGC3626	$^{12}CO(2-1)$ $^{12}CO(1-0)$	S.Garcia-Burillo M.J.Sempere D.Bettoni
G050	Simultaneous Multi Frequency Observations of Comet C/1995 OI Hale-Bopp II. Dual frequency Continuum observations with the PdB Interferometer	Cont 3mm Cont 1mm	W.J.Altenhoff E.Kreysa J.Schmidt Stumpff Bieging Mauersberger Thum Wink Sievers Butler McMullin
G052	Estimating the density of the molecular filaments in the Photodissociation Region (PDR) associated with NGC7023	CS(5-4) CS(2-1)	A.Fuente J.Martín-Pintado R.Neri
G053	OH231.8+4.2: A unique target to study protoplanetary dynamics	$^{12}CO(2-1)$ $^{12}CO(1-0)$	C.Sánchez-Contreras J.Alcolea V.Bujarrabal R.Neri
G054	High resolution 1mm observations of M1-92 (Minkowski's Footprint)	$^{13}CO(2-1)$ $^{13}CO(1-0)$	J.Alcolea V.Bujarrabal R.Neri
G056	The disk-outflow structure in IRAS20126+4104	$H_3CN(12-11)$ SiO(2-1)	R.Cesaroni M.Felli R.Neri L.Olmi C.M.Walmsley
G057	Dust emission and HCO^+ foreground absorption in Cassiopeia A	Cont 1mm HCO^+	J.Lequeux P.Encrenaz P.O.Lagage L.Loinard
G058	The outflow in the Class 0 source Cep E	$^{12}CO(2-1)$ SiO(2-1)	B.Lefloch B.Lazareff J.Eislöffel R.Neri
G063	The detached envelope around the carbon star TT Cyg	$^{12}CO(2-1)$ $^{12}CO(1-0)$	H.Olofsson R.Lucas P. Bergmann J.Bieging K.Eriksson B.Gustafsson
G064	A New Technique to Locate SiO Shells around Stellar Photospheres	SiO(2-1)	A.Baudry R.Lucas
G065	Widespread interstellar C_2H absorption ?	C_2H	R.Lucas, H.S.Liszt
G067	Disks in the GG Tau multiple system	$^{13}CO(2-1)$ HCO^+	S.Guilloteau A.Dutrey M.Simon
G069	Probing the density distribution in the GM Aur disk	$C^{18}O(2-1)$ $^{13}CO(1-0)$	A.Dutrey S.Guilloteau G.Duvert F.Ménard M.Simon L.Prato
G070	Spectral snaphosts of Comet Hale-Bopp near perihelion	CO(2-1) CH_3OH CS(5-4) H_2CO HCN(1-0) CH_3OH $^{12}CO(1-0)$ CS(2-1)	D.Bockelée-Morvan N.Biver P.Colom J.Crovisier E.Gérard H.Rauer D.Despois R.Moreno G.Paubert J.K.Davies W.Dent

	Title	Line	Authors
G073	Water abundance in molecular Cores: Interferometry of $H_2^{18}O$ and HDO	HDO225 NH_2D	P.Gensheimer T.L.Wilson A.Baudry T.Jacq
G074	Molecular Clouds in the Nucleus of NGC1068: Properties of Bar Inflow and of the Obscuring Medium	^{12}CO(2-1) ^{12}CO(1-0)	L.Tacconi D.Downes J.Gallimore E.Schinnerer R.Genzel
G078	Size Measurements in Disks of YSO at 1.3mm-Long Baselines	^{13}CO(2-1) ^{13}CO(1-0)	A.Dutrey S.Guilloteau K.Schuster G.Duvert M.Simon L.Prato F.Ménard
G079	Map of the 1mm emission and search for ^{12}CO in dusty high z radioquiet QSOs	Cont 1mm ^{12}CO	A.Omont S.Guilloteau R.G.McMahon P.Cox P.Petitjean
G080	Probing the inner circumstellar environment of protostars (II)	HC_3N, $C^{18}O$ Cont 1mm	F.Motte F.Gueth P.André A.Dutrey S.Guilloteau R.Neri
G082	Circumstellar Disks in the Trapezium Cluster	Cont 1mm	E.A.Lada L.Mundy S.Guilloteau A.Dutrey
G083	The ^{12}CO "jet" in HH211	^{12}CO(2-1) ^{12}CO(1-0)	F.Gueth S.Guilloteau
G089	The hot interstellar medium of M82	^{12}CO(2-1) ^{12}CO(1-0)	N.Neininger R.Wielebinski U.Klein H.-P.Reuter
G092	High-velocity gas in ultraluminous IR Galaxies	^{12}CO(2-1) ^{12}CO(1-0)	D.Downes P.Solomon
G093	High-spatial resolution ^{12}CO map of the nucleus of NGC 4258	^{12}CO(2-1) ^{12}CO(1-0)	P.Cox D.Downes
G094	High-resolution observations of Arp299	^{12}CO(2-1) HCN(1-0)	F.Casoli M.C.Willaime F.Viallefond J.Hibbard M.Gérin
G095	High-resolution observations of the nucleus of NGC 3079	^{12}CO(2-1) ^{12}CO(1-0)	L.Tacconi D.Downes R.Genzel
G097	^{13}CO and $C^{18}O$ in the Nuclear Region of IC342	^{13}CO(2-1) $C^{18}O$ ^{13}CO HNCO	F.Viallefond Dinh-Van-Trung Nguyen Quang Rieu
G098	The Dynamics and Gas Content in the Central 100pc of the Seyfert 1 NGC 3227	^{12}CO(2-1) ^{12}CO(1-0)	E.Schinnerer A.Eckart L.Tacconi L.Tacconi-Garman
G099	The protostellar candidate HH24 MMS (II) Planetary Formation Models	CS(5-4) ^{12}CO(1-0)	E.Krügel R.Chini C.Thum
G102	NGC 2146: a starburst galaxy with evident molecular outflow into the halo	^{12}CO(2-1) ^{13}CO(1-0)	A.Greve N.Neininger U.Klein
G103	CS(5-4) Mapping of the infall candidate B335	CS(5-4)	P.Myers D.Mardones D.Wilner
G- -2	Is there ^{12}CO emission in a second lens toward the QSO PKS1830-211 ?	^{12}CO(1-0)	F.Combes T.Wiklind
H001	Spectroscopic study of a protostellar	HCO^+	J.-F.Panis M.Choi
H004	Further observations in front of 3C111	$HC^{18}O^+$ SiO CH_3CN	R.Lucas H.Liszt
H005	Extending to the mm range the radio spectrum of Chemically Peculiar stars	Cont 3mm	F.Leone C.Trigilio G.Umana R.Neri

Ident.	Title	Line	Authors
H009	^{13}CO and $C^{18}O$ in the Nuclear Region of IC342 ^{13}CO(2-1)	$C^{18}O$ ^{13}CO HNCO	F.Viallefond Nguyen Quang Rieu Dinh-Van-Trung
H011	The nature of B[e] stars	H40α Cont 1mm	C.Thum D.Morris E.Kreysa
H014	^{12}CO map of ARP193: ^{12}COmpletion	^{12}CO(1-0) ^{12}CO(2-1)	D.Downes P.Solomon
H016	Streaming motions at a 10pc scale in molecular arms	^{12}CO(1-0)	N.Neininger M.Guélin R.Lucas R.Wielebinski S.Garcia-Burillo H.Ungerechts
H022	Resolving infall in the protostellar group NGC1333/IRAS4	N_2H^+ H_2CO	P.Myers J.DiFrancesco D.Wilner D.Mardones
H023	The SiO structure of the NGC1333/IRAS2 western bow shock	SiO(2-1) SiO(5-4)	A.Castets B.Lefloch R.Neri W.D.Langer
H024	Young planetary nebulae with jets	^{12}CO(1-0) ^{12}CO(2-1)	T.Forveille P.Huggings R.Bachiller P.Cox
H025	Young planetary nebulae with jets	^{12}CO(1-0) ^{12}CO(2-1)	T.Forveille P.Huggings R.Bachiller P.Cox
H032	Vibrationaly Excited Cyanoacetylene in G10.47	HC_3N(12-11)	F.Wyrowski C.M.Walmsley P.Schilke
H033	Dense Clumps in the Orion Bar	$H^{13}CN$(1-0) $H^{13}CO^+$(1-0)	P.Schilke F.Wyrowski D.C.Lis M.Walmsley J.Keene T.G.Phillips
H034	Physical structure of the DM Tau protoplanetary disk	C_2H(1-0) CN(2-1)	S.Guilloteau A.Dutrey M.Guélin
H038	Gas dynamics in the nuclear bar of NGC5850	^{12}CO(1-0)	S.Leon F.Combes D.Friedli
H039	^{12}COunterrotating stellar and gaseous disks in NGC3593	^{12}CO(1-0)	S.Garcia-Burillo M.Sempere D.Bettoni
H041	A high resolution map of the clumpy irregular galaxy Mrk297	^{12}CO(1-0)	S.Hüttenmeister U.Klein N.Neininger A.Greve
H042	A high resolution map of an intergalactic molecular ^{12}COmplex	^{12}CO(1-0)	S.Hüttenmeister S.Kohle J.Braine N.Brouillet W.Baan C.Henkel
H043	Extended nebulae in symbiotic systems: CH Cyg, AG Peg and R Aqr	Cont 3mm Cont 1mm	J.Mikolajewska A.Omont R.Neri
H044	A mysterious 1mm Continuum source next to the Cloverleaf Quasar	^{12}CO(2-1)	R.Barvainis R.Antonucci D.Alloin S.Guilloteau
H045	The powerful outflow in the G9.62+0.19F hot Core	Cont 3mm	P.Hofner Th.Henning
H049	Search for the gas and dust Content of WTTS disks	HCO^+(1-0) ^{12}CO(2-1)	A.Dutrey F.Ménard K.Schuster G.Duvert S.Guilloteau M.Simon
H050	The ^{12}CO torus in the Butterfly nebula M2-9	^{12}CO(1-0)	J.Zweigle R.Bachiller V.Bujarrabal M.Grewing R.Neri
H051	The distribution and kinematics of the molecular gas in a BCDG	^{12}CO(1-0)	T.Fritz A.Heithausen U.Klein N.Neininger C.L.Taylor W.Walsh

Ident.	Title	Line	Authors
H054	100AU-scale clumping in the molecular cloud MBM12	CS(2-1) ^{13}CO(2-1)	F.Combes D.Pfenniger
H057	The central region if NGC4631 in ^{12}CO(1-0)	^{12}CO(1-0)	M.Krause M.Dumke R.Wielebinski
H058	^{13}CO in the rotating nuclear ring in VII Zwicky 31	^{13}CO(1-0) ^{13}CO(2-1)	D.Downes P.Solomon
H059	Map of the 1mm emission and search for ^{12}CO in two prominent high z radioquiet QSOs	^{12}CO(3-2)	A.Omont S.Guilloteau P.Cox R.G.McMahon P.Petitjean
H060	Map of the 1mm emission and search for ^{12}CO in two prominent high z radioquiet QSOs	^{12}CO(4-3)	A.Omont S.Guilloteau P.Cox R.G.McMahon P.Petitjean
H061	Images of the shock-chemistry stratifications in bipolar outflows: L1157	HCN(1-0) CH_3OH(5-4)	M.P.Gutiérrez R.Bachiller F.Gueth S.Guilloteau A.Dutrey M.Tafalla
H062	Images of the shock-chemistry stratifications in bipolar outflows: L1157	CH_3OH(2-1) CH_3OH(5-4)	M.P.Gutiérrez R.Bachiller F.Gueth S.Guilloteau A.Dutrey M.Tafalla
H063	Multiplicity and infall in a nearby embedded cluster: IRAM PdBI observations of the Serpens star-forming region	$C^{34}S$(2-1) CS(5-4)	P.Myers J.Di Francesco J.Williams D.Wilner D.Mardones
H064	A rotating molecular disk in the center of Arp193	^{12}CO(1-0) ^{12}CO(2-1)	D.Downes P.Solomon
H065	High-resolution observations of ultraluminous IR galaxies	^{12}CO(1-0)	D.Downes M.Bremer J.Zweigle
H066	Dust emission and HCO^+ foreground absorption in Cassiopeia A	HCO^+(1-0) Cont 1mm	J.Lequeux P.Encrenaz P.O.Lagage L.Loinard T.Douvion

8. ANNEX II : PUBLICATIONS/ 8.1 PUBLICATIONS WITH IRAM STAFF MEMBERS AS (CO-)AUTHORS

627. DETECTION OF A NEW LINEAR CARBON CHAIN RADICAL: C_7H
M. Guélin, J. Cernicharo, M.J. Travers, M.C. McCarthy, C.A. Gottlieb, P. Thaddeus, M. Ohishi, S. Saito, S. Yamamoto
1997, A&A 317, L1

CHEMISTRY OF PROTOSOLAR-LIKE NEBULAE: The molecular content of the DM Tau and GG Tau disks
A. Dutrey, S. Guilloteau, M. Guélin
1997, A&A 317, L55

^{14}C IN AGB STARS: The case of IRC+10216
M. Forestini, M. Guélin, J. Cernicharo
1997, A&A 317, 883

THE ANATOMY OF AN ISOLATED SPIRAL GALAXY: NGC 4414
J. Braine, N. Brouillet, A. Baudry
1997, A&A 318, 19

A HIGH-RESOLUTION $^{12}CO(1-0)$ STUDY OF THE NUCLEUS OF NGC 5907 Observations and modelling
S. Garcia-Burillo, M. Guélin, N. Neininger
1997, A&A 319, 450

SHOCKS AND RING IN THE BARRED SPIRAL GALAXY NGC 1530
D. Reynaud, D. Downes
1997, A&A 319, 737

HIGH RESOLUTION STUDIES OF PROTOSTELLAR CONDENSATIONS IN NGC 2024
H. Wiesemeyer, R. Güsten, J.E. Wink, H.W. Yorke
1997, A&A 320, 287

THE MASS AND TEMPERATURE DISTRIBUTION IN THE PROTOPLANETARY NEBULA M 1-92: ^{13}CO INTERFEROMETRIC OBSERVATIONS
V. Bujarrabal, J. Alcolea, R. Neri, M. Grewing
1997, A&A 320, 540

635. MILLIMETER INTERFEROMETRY TOWARDS THE ULTRA-COMPACT HII REGION W3(OH)
F. Wyrowski, P. Hofer, P. Schilke, C.M. Walmsley, D.J. Wilner, J.E. Wink
1997, A&A 320, L17

636. THE GRAVITATIONAL LENSING NATURE OF THE CLOVERLEAF UNVEILED IN CO(7-6) LINE EMISSION
D. Alloin, S. Guilloteau, R. Barvainis, R. Antonucci, L. Tacconi
1997, A&A 321, 24

637. A SEARCH FOR MOLECULAR GAS IN IN HIGH REDSHIFT RADIO GALAXIES
R. van Ojik, H.J.A. Röttgering, J. Wink et al.
1997, A&A 321, 389

638. THE MOLECULAR ENVELOPE AROUND T TAURI AND THE NATURE OF NGC 1555
K.-F. Schuster, A.I. Harris, A.P.G. Russell
1997. A&A 321. 568

639. THE NEUTRAL GAS CONTENT OF X-RAY BRIGHT ELLIPTICAL GALAXIES
J. Braine, C. Henkel, T. Wiklind
1997. A&A 321. 765

640. ORFEUS OBSERVATIONS OF S VI, O VI AND P V IN THE STELLAR WIND FROM THE NUCLEUS OF NGC 6543
J. Zweigle, M. Grewing, J. Barnstedt, M. Gölz, W. Gringel, C. Haas, W. Hopfensitz, N. Kappelmann, G. Krämer, I. Appenzeller, J. Krautter, H. Mandel
1997, A&A 321, 891

641. MOLECULAR HYDROGEN MORPHOLOGY, KINEMATICS AND EXCITATION IN AFGL 2688 AND NGC 7027
P. Cox, J.-P. Maillard, P.J. Huggins, T. Forveille, D. Simons, S. Guilloteau, F. Rigaut, R. Bachiller, A. Omont
1997, A&A 321, 907

642. PULSAR DETECTION AT 87 GHZ
D. Morris, M. Kramer, C. Thum, R. Wielebinski, M. Grewing, J. Penalver, A. Jessner, G. Butin, W. Brunswig
1997. A&A 322. L17

MOLECULAR EXCITATION IN
CENTAURUS A: the ^{13}CO J=1-0 map
and CO line ratios
W. Wild, A. Eckart, T. Wiklind
1997, A&A 322, 419

CO EMISSION FROM 3C48
J.E. Wink, S. Guilloteau, T.L. Wilson
1997, A&A 322, 427

THE EXTENDED 1.3 MM CONTINUUM
EMISSION AROUND CW LEO
M.A.T. Groenewegen, W.E.C.J. van der Veen,
B. Lefloch, A. Omont
1997, A&A 322, L21

AN OBSERVATIONAL STUDY OF
COMETARY GLOBULES NEAR THE
ROSETTE NEBULA
G.J. White, B. Lefloch, C.V.M. Fridlund,
C.A. Aspin, G. Dahmen, N.R. Minchin,
M. Huldtgren
1997, A&A 323, 931

STRUCTURE AND KINEMATICS OF A
PROTOSTAR: MM-Interferometry of L1157
F. Gueth, S. Guilloteau, A. Dutrey, R. Bachiller
1997, A&A 323, 943

648. 215 GHz VLBI OBSERVATIONS OF BRIGHT
ACTIVE GALACTIC NUCLEI
T.P. Krichbaum, D.A. Graham, A. Greve,
J.E. Wink, J. Alcolea, F. Colomer,
P. de Vicente, A. Baudry, J. Gomez-Gonzales,
M. Grewing
1997, A&A 323, L17

^{12}CO J = 1-0 SYNTHESIS IMAGES
OF A DENSE TORUS IN M 2-9
J. Zweigle, R. Neri, R. Bachiller,
V. Bujarrabal, M. Grewing
1997, A&A 324, 624

THE INTERSTELLAR MEDIUM IN THE
EDGE-ON GALAXY NGC 5907
M. Dumke, J. Braine, M. Krause, R.Zylka,
R. Wielebinski, M. Guélin
1997, A&A 325, 124

COLD DUST AROUND HERBIG-HARO
ENERGY SOURCES: Morphology and
New Protostellar Candidates
R. Chini, Bo Reipurth, A. Sievers,
D. Ward-Thompson, C.G.T. Haslam,
E. Kreysa, R. Lemke
1997, A&A 325, 542

652. SUCCESSIVE SiO SHOCKS ALONG
THE L1448 JET AXIS
A. Dutrey, S. Guilloteau, R. Bachiller
1997, A&A 325, 758

653. GAS SEGREGATION IN THE
INTERACTING SYSTEM ARP 105
P.-A. Duc, E. Brinks, J.E. Wink,
I.F. Mirabel
1997, A&A 326, 537

654. GAS AND DUST IN THE ACTIVE
SPIRAL GALAXY NGC 3079
J. Braine, M. Guélin, M. Dumke,
N. Brouillet, F. Herpin, R. Wielebinski
1997, A&A 326, 963

655. THE HIGH-FREQUENCY COMPACT
RADIO STRUCTURE OF THE
PECULIAR QUASAR 4C39.25
A. Alberdi, A. Greve, et al.
1997, A&A 327, 513

656. THE SECOND DETECTION OF CO
AT REDSHIFT LARGER THAN 4
S. Guilloteau, A. Omont, R.G. McMahon,
P. Cox, P. Petitjean
1997, A&A 328, L1

657. MILLIMETRE CONTINUUM
MEASUREMENTS OF EXTRAGALACTIC
RADIO SOURCES
IV. Data from 1993-1994*
H.-P. Reuter, C. Kramer, A. Sievers, G. Paubert,
R. Moreno, A. Greve, S. Leon, J.F. Panis,
M. Ruiz-Moreno, H. Ungerechts, W. Wild
1997, A&A Suppl. Series 122, 271

658. DUST FILAMENTS AND STAR FORMATION
IN OMC-2 AND OMC-3
R. Chini, B. Reipurth, D. Ward-Thompson,
J. Bally, L.-A. Nyman, A. Sievers, Y. Billawala
1997, ApJ 474, L135

659. THE MOLECULAR INTERSTELLAR
MEDIUM IN ULTRALUMINOUS
INFRARED GALAXIES
P.M. Solomon, D. Downes,
S.J.E. Radford, J.W. Barrett
1997, ApJ 478, 144

660. A NEW GENERATION OF
PHOTOIONIZATION CODES:
THREE-DIMENSIONAL MODELS.
THE BIPOLAR PLANETARY
NEBULA IC 4406
R. Gruenwald, S.M. Viegas, D. Broguière
1997, ApJ 480, 283

MOLECULAR GAS IN THE SPECTACULAR RING GALAXY NGC 1144
Y. Gao, P.M. Solomon, D. Downes, S.J.E. Radford
1997, ApJ 481, L35

CHEMICAL AND PHYSICAL GRADIENTS ALONG THE OMC-1 RIDGE
H. Ungerechts, E.A. Bergin, P.F. Goldsmith, W.M. Irvine, F.P. Schloerb, R.L. Snell
1997, ApJ 482, 245

A SURVEY OF THE CHEMICAL PROPERTIES OF THE M17 AND CEPHEUS A CLOUD CORES
E.A. Bergin, H. Ungerechts, P.F. Goldsmith, R.L. Snell, W.M. Irvine, F.P. Schloerb
1997, ApJ 482, 267

MILLIMETER AND RADIO INTERFEROMETRY OF HERBIG Ae/Be STARS
J. Di Francesco, N.J. Evans II, P.M. Harvey,
1997, ApJ 482, 433

665. EVOLUTION OF THE OUTGASSING OF COMET HALE-BOPP (C/1995 O1)
N. Biver, D. Bockelée-Morvan, P. Colom, J. Crovisier, J.K. Davies, W.R.F. Dent, D. Despois, E. Gérard, E. Lellouch, H. Rauer, R. Moreno, G. Paubert
1997, Science 275, 1915

666. MILLIMETER AND SUBMILLIMETER HETERODYNE OBSERVATIONS OF TITAN: RETRIEVAL OF THE VERTICAL PROFILE OF HCN AND THE ^{12}C/^{13}C RATIO
T. Hidayat, A. Marten, B. Bézard, D. Gautier, T. Owen, H.E. Matthews, G. Paubert
1997, Icarus 126, 170

MILLIMETRIC AND OPTICAL OBSERVATIONS OF CHIRON
H. Rauer, N. Biver, J. Crovisier, D. Bockelee-Morvan, P. Colom, D. Despois, W.-H. Ip, L. Jorda, E. Lellouch, G. Paubert, N. Thomas
1997, Plan. & Space Sci. 45, 799

MILLIMETER-WAVE ABSORPTION STUDIES OF THE ONSET OF DARK-CLOUD CHEMISTRY
R. Lucas, H.S. Liszt
1997, in CO: Twenty-Five Years of Millimeter-Wave Spectroscopy,
ed. B. Latter et al., Kluwer, Dordrecht, 95

669. SURVEYS WITH HETERODYNE FOCAL PLANE ARRAYS AT MM WAVELENGTHS: QUARRY AT FCRAO
H. Ungerechts
1997, in CO: Twenty-Five Years of Millimeter-Wave Spectroscopy,
ed. B. Latter et al., Kluwer, Dordrecht, 181

670. CENTAURUS A: The ^{13}CO Map and Molecular Line Ratios
W. Wild, A. Eckart, M. Cameron, R. Genzel, H. Rothermel, G. Rydbeck, T. Wiklind
1997, in CO: Twenty-Five Years of Millimeter-Wave Spectroscopy,
ed. B. Latter et al., Kluwer, Dordrecht, 338

671. MASS LOSS IN AGB STARS
M. Guélin, R. Lucas, R. Neri
1997, in CO: Twenty-Five Years of Millimeter-Wave Spectroscopy,
ed. B. Latter et al., Kluwer, Dordrecht, 359

672. THE MOLECULAR OUTFLOW AND CO BULLETS IN HH111
J. Cernicharo, R. Neri, B. Reipurth
1997, in Herbig-Haro Flows and the Birth of Low Mass Stars
eds. B. Reipurth and C. Bertout
Kluwer, Dordrecht, 141

673. MODELS OF BIPOLAR MOLECULAR OUTFLOWS
S. Cabrit, A. Raga, F. Gueth
1997, in Herbig-Haro Flows and the Birth of Low Mass Stars
eds. B. Reipurth and C. Bertout

674. DISKS AND OUTFLOWS AS SEEN FROM THE IRAM INTERFEROMETER
S. Guilloteau, A. Dutrey, F. Gueth
1997, in Herbig-Haro Flows and the Birth of Low Mass Stars
eds. B. Reipurth and C. Bertout
Kluwer, Dordrecht, 365

675. THE EVOLUTION OF FLOWS AND PROTOSTARS
P. André
1997, in Herbig-Haro Flows and the Birth of Low Mass Stars
eds. B. Reipurth and C. Bertout
Kluwer, Dordrecht, 483

676. RADIO INTERFEROMETRY
S. Guilloteau
1997, in High Angular Resolution in Astrophysics
eds. A.-M. Lagrange et al.
Kluwer, Dordrecht, 145

LES OBSERVATIONS DES NUAGES MOLECULAIRES DIFFUS EN ABSORPTION MILLIMETRIQUE
R. Lucas
1997, C.R. Acad. Sci. Paris, 605

RECENT RESULTS FROM IRAM
M. Grewing
1997, in The Far IR and Submm Universe, ESA SP-401
ed. A. Wilson
ESTEC, Noordwijk, 219

679. WARPED COLD DUST DISKS OF SPIRAL GALAXIES
N. Neininger, M. Dumke, M. Guélin, R. Zylka
1997, in The Far IR and Submm Universe, ESA SP-401
ed. A. Wilson
ESTEC, Noordwijk, 317

680. NIOBIUM NITRIDE MIXER WITH NIOBIUM TUNING CIRCUIT
B. Plathner, M. Schicke, T. Lehnert, K.H. Gundlach, H. Rothermel, M. Aoyagi, S. Takada
1996, Appl. Phys. Lett., 69, 4102

LOW NOISE SIS MIXER FOR 230 GHz RECEIVERS OF PLATEAU DE BURE INTERFEROMETER
A. Karpov, J. Blondel, K.H. Gundlach, D. Billion-Pierron
1997, Int. Journ. IR + MM Waves, 18, 301

A WIDEBAND VARIABLE WAVEGUIDE COUPLER FOR MILLIMETER APPLICATIONS
K.-F. Schuster, M. Carter, D. Charrière, J. Lamb, F. Mattiocco
1997, IEEE Microwave and Guided Wave Letters, 7, 197

683. LOW NOISE DIRECT DETECTOR AT SUBMILLIMETER WAVELENGTH USING SIS JUNCTION
A. Karpov, J. Blondel, M. Voss, K.H. Gundlach
1997, in IEEE MTT-S International Microwave Symposium Digest
eds. C. Jelks, G.A. Koepf, D. Huebner, J.J. Donovan
The Institute of Electrical and Electronic Engineers, Inc., NY, 919

684. CASSEGRAINIAN/GREGORIAN-TYPE NULL CORRECTORS FOR SURFACE MEASUREMENTS OF RADIO TELESCOPE REFLECTORS
A. Greve
1997, Applied Optics 36, 5283

685. A WIDE BAND HYBRID DIGITAL CORRELATOR SPECTROMETER FOR THE FIRST-HET INSTRUMENT
M. Giard, Ph. Cais, L. Ravera, M. Torres, J.L. Noullet, A. Baudry, A. Ferreira, D. Lagrange, J.Y. Mayvial, G. Montignac, G. Serra
1997, in The Far IR and Submm Universe, ESA SP-401
ed. A. Wilson
ESTEC, Noordwijk, 373

686. LOW NOISE SIS DIRECT DETECTOR AT SUBMILLIMETER WAVELENGTH
A. Karpov, J. Blondel, M. Voss, K.H. Gundlach
1997, in The Far IR and Submm Universe, ESA SP-401
ed. A. Wilson
ESTEC, Noordwijk, 391

687. DIGITAL GAAS CORRELATOR ASICS FOR FIRST
L. Ravera, M. Giard, D. Lagrange, G. Serra, J.L. Noullet, A. Ferreira, M. Torres, J.Y. Mayvial
1997, in The Far IR and Submm Universe, ESA SP-401
ed. A. Wilson
ESTEC, Noordwijk, 409

688. NbN TUNNEL JUNCTIONS WITH Al STRIPLINES AND NbN TRANSITION-EDGE BOLOMETERS FOR TERAHERTZ MIXERS
M.Schicke, T. Lehnert, K.H. Gundlach, H. Rothermel, P. Dieleman, T.M. Klapwijk, H. van de Stadt
1997, in The Far IR and Submm Universe, ESA SP-401
ed. A. Wilson
ESTEC, Noordwijk, 421

689. DC MEASUREMENTS WITH NbN SIS MIXER ELEMENTS FOR FREQUENCIES FROM 800 to 1500 GHz
D. Hottgenroth, C.E. Honingh, S. Haas, K. Jacobs, J. Stutzki, M. Schicke, K.H. Gundlach
1997, in ISEC'97, Extended Abstracts, Vol. 3: Microwave Devices, SQUIDs and OTHER APPLICATIONS, M21, 147

690. NbN TUNNEL JUNCTIONS WITH Al TUNING CIRCUITS AND HOT-ELECTRON TRANSITION-EDGE BOLOMETERS FOR THz MIXING
M. Schicke, T. Lehnert, K.H. Gundlach, M. Aoyagi, S. Takada, H. Rothermel, P. Dieleman, T.M. Klapwijk, H. van de Stadt
1997, in ISEC'97, Extended Abstracts, Vol. 3: Microwave Devices, SQUIDs and OTHER APPLICATIONS, M22, 150

691. A 125-180 GHz FIXED-TUNED SIS MIXER FOR RADIOASTRONOMY
A. Karpov, J. Blondel, P. Pasturel, K.H. Gundlach
1997, IEEE Transactions on Applied Superconductivity, 7, 1073

692. NOISE AND GAIN IN FREQUENCY MIXERS WITH NbN SIS JUNCTIONS
A. Karpov, B. Plathner, J. Blondel, M. Schicke, K.H. Gundlach, M. Aoyagi, S. Takada
1997, IEEE Transactions on Applied Superconductivity, 7, 1077

693. NbN-MgO-NbN JUNCTIONS PREPARED ON ROOM TEMPERATURE QUARTZ SUBSTRATES FOR QUASIPARTICLE MIXERS
B. Plathner, M. Schicke, T. Lehnert, K.H. Gundlach, H. Rothermel, M. Aoyagi, S. Takada
1997, IEEE Transactions on Applied Superconductivity, 7, 2603

8. ANNEX II : PUBLICATIONS/ 8.2 USERS' PUBLICATIONS WITH RESULTS FROM THE IRAM OBSERVATORIES

CHEMICAL INHOMOGENEITIES IN INTERSTELLAR CLOUDS: The High Latitude Cloud MCLD 123.5+24.9
M. Gérin, E. Falgarone, K. Joulain, M. Kopp, J. Le Bourlot, G. Pineau des Forêts, E. Roueff, P. Schilke
1997, A&A 318, 579

A CORRELATION BETWEEN CO LINEWIDTH AND STARBURST AGE IN BARRED SPIRAL GALAXIES
T. Contini, H. Wozniak, S. Considère, E. Davoust

A SURVEY OF CN IN CIRCUMSTELLAR ENVELOPES
R. Bachiller, A. Fuente, V. Bujarrabal, F. Colomer, C. Loup, A. Omont, T. de Jong
1997, A&A 319, 235

587. SiO HIGH VELOCITY MASER EMISSION IN O-RICH EVOLVED STARS
J. Cernicharo, J. Alcolea, A. Baudry, E. Gonzalez-Alfonso
1997, A&A 319, 607

SUPERWIND IN EVOLVED OH/IR STARS
X. Delfosse, C. Kahane, T. Forveille
1997, A&A 320, 249

STAR FORMATION IN THE S235 A-B COMPLEX
M. Felli, L. Testi, R. Valdettaro, Jun-Jie Wang
1997, A&A 320, 594

A HOT RING IN THE SAGITTARIUS B2 MOLECULAR CLOUD
P. de Vicente, J. Martin-Pintado, T.L. Wilson
1997, A&A 320, 957

THERMAL METHANOL EMISSION IN THE DR21 COMPLEX
S. Liechti, C.M. Walmsley
1997, A&A 321, 625

MOLECULAR GAS IN THE WARPED GALAXY NGC 4013
A.I. Gomez de Castro, S. Garcia-Burillo
1997, A&A 322, 381

594. SEARCH FOR 183 GHz WATER MASER EMISSION IN STARBURST GALAXIES
F. Combes, Nguyen-Q-Rieu, Dinh-V-Trung
1997, A&A 323, 357

595. MOLECULAR GAS IN THE ELLIPTICAL GALAXY NGC 759
Interferometric CO Observations
T. Wiklind, F. Combes, C. Henkel, F. Wyrowski
1997, A&A 323, 727

596. CIRCUMNUCLEAR MOLECULAR GAS AND STAR FORMATION IN STARBURST GALAXIES
P. Planesas, L. Colina, D. Pérez-Olea
1997, A&A 325, 81

597. THE DISK-OUTFLOW SYSTEM AROUND THE HIGH-MASS (PROTO) STAR IRAS 20126+4104
R. Cesaroni, M. Felli, L. Testi, C.M. Walmsley, L. Olmi
1997, A&A 325, 725

598. MOLECULAR GAS IN THE BARRED SPIRAL M100
I. The IRAM 30m Map
M.J. Sempere, S. Garcia-Burillo
1997, A&A 325, 769

599. DENSE GAS IN NEARBY GALAXIES
X. H_2CO and CH_3OH: Molecular Abundances and Physical Conditions
S. Hüttemeister, R. Mauersberger, C. Henkel
1997, A&A 326, 59

600. MILLIMETRE DUST EMISSION FROM NORTHERN BOK GLOBULES
R. Launhardt, Th. Henning
1997, A&A 326, 329

601. A MOLECULAR AND INFRARED STUDY OF NGC 2264 IRS1
K.Schreyer, F.P.Helmich, E.F.van Dishoek, T.H.Henning
1997, A&A 326, 347

602. VERTICAL EQUILIBRIUM OF MOLECULAR GAS IN GALAXIES
F. Combes, J.-F. Becquaert
1997, A&A 326, 554

603. NEW UPPER LIMITS ON THE INTERSTELLAR O_2 ABUNDANCE
F. Combes, T. Wiklind, N. Nakai
1997, A&A 327, L17

604. MOLECULAR ABSORPTION LINES AT HIGH REDSHIFT: PKS 1413+135 (z=0.247)
T. Wiklind, F. Combes
1997, A&A 328, 48

605. A STUDY OF THE MUTUAL INTERACTION BETWEEN THE MONOCEROS R2 OUTFLOW AND ITS SURROUNDING CORE
M. Tafalla, R. Bachiller, M.C.H. Wright, W.J. Welch
1997, ApJ 474, 329

606. THE EXTRAORDINARY OUTFLOW TOWARD G5.89-0.39
J.M. Acord, C.M. Walmsley, E. Churchwell
1997, ApJ 475, 693

607. THE NEUTRAL INTERSTELLAR MEDIUM IN NEARBY DWARF GALAXIES. II. NGC 185, NGC 205, and NGC 147
L.M. Young, K.Y. Lo
1997, ApJ 476, 127

608. DENSE GAS AND STAR FORMATION: CHARACTERISTICS OF CLOUD CORES ASSOCIATED WITH WATER MASERS
R. Plume, D.T. Jaffe, N.J. Evans II, J. Martin-Pintado, J. Gomez-Gonzales
1997, ApJ 476, 730

609. DETECTION OF CO^+ TOWARD THE REFLECTION NEBULA NGC 7023
A. Fuente, J. Martin-Pintado
1997, ApJ 477, L107

610. SiO EMISSION FROM THE GALACTIC CENTER MOLECULAR CLOUDS
J. Martin-Pintado, P. de Vicente, A. Fuente, P. Planesas
1997, ApJ 482, L45

611. PHYSICAL PARAMETERS OF THE IRC +10216 CIRCUMSTELLAR ENVELOPE: NEW CONSTRAINTS FROM SUBMILLIMETER OBSERVATIONS
M. Crosas, K.M. Menten
1997, ApJ 483, 913

612. A MOLECULAR DISK AROUND THE EPISODIC JETS IN KjPn 8
P.J. Huggins, R. Bachiller, P. Cox, T. Forveille
1997, ApJ 483, L57

613. MULTIPLE CO TRANSITIONS, C I, AND HCN FROM THE CLOVERLEAF QUASAR
R. Barvainis, P. Maloney, R. Antonucci, D. Alloin
1997, ApJ 484, 695

614. CIRCUMSTELLAR GAS IN THE WIDE BINARY HD 188037
M. Jura, C. Kahane, D. Fischer, C. Grady
1997, ApJ 485, 341

615. SHOCK CHEMISTRY IN THE YOUNG BIPOLAR OUTFLOW L1157
R. Bachiller, M. Pérez Gutiérrez
1997, ApJ 487, L93

616. A SEARCH FOR THE CO-H_2 DIMER IN THE GALAXY
R.J. Allen, L. Loinard, A.R.W. McKellar, J. Lequeux
1997, ApJ 489, 102

617. TRACING THE ENVELOPES AROUND EMBEDDED LOW-MASS YOUNG STELLAR OBJECTS WITH HCO^+ AND MILLIMETER-CONTUNUUM OBSERVATIONS
M.R. Hogerheijde, E.F. van Dishoeck, G.A. Blake, H.J. van Langevelde
1997, ApJ 489, 293

618. A SEARCH FOR INFALL MOTIONS TOWARD NEARBY YOUNG STELLAR OBJECTS
D. Mardones, P.C. Myers, M. Tafalla, D.J. Wilner, R. Bachiller, G. Garay
1997, ApJ 489, 719

619. MOLECULAR GAS AND STAR FORMATION WITHIN GALAXIES IN THE BOOTES VOID
L.J. Sage, D. Weistrop, S. Cruzen, C. Kömpe
1997, Astron. J. 114, 1753

620. SUBMILLIMETRE PHOTOMETRY OF PROTOSTELLAR CORES IN BOK GLOBULES
R. Launhardt, D. Ward-Thompson, Th. Henning
1997, Mon. Not. R. Astron. Soc., 288, L45

621. THE NUCLEAR STELLAR CLUSTER IN NGC 1068
N. Thatte, R. Genzel, L. Tacconi, A. Krabbe, H. Kroker
1997, RevMexAA (Conferencias), 6, 227

OBSERVATIONAL CHEMISTRY
C.M. Walmsley
1997, in CO: Twenty-Five Years of
Millimeter-Wave Spectroscopy,
ed. B. Latter et al., Kluwer, Dordrecht, 79

CO OUTFLOWS FROM YOUNG STARS
B. Reipurth, R. Bachiller
1997, in CO: Twenty-Five Years of
Millimeter-Wave Spectroscopy,
ed. B. Latter et al., Kluwer, Dordrecht, 165

STAR FORMATION AND GAS CONTENTS
IN DISK GALAXIES: Complex Relationships
F. Casoli
1997, in CO: Twenty-Five Years of
Millimeter-Wave Spectroscopy,
ed. B. Latter et al., Kluwer, Dordrecht, 286

MOLECULAR GAS IN ULTRALUMINOUS
INFRARED GALAXIES
P.M. Solomon
1997, in CO: Twenty-Five Years of
Millimeter-Wave Spectroscopy,
ed. B. Latter et al., Kluwer, Dordrecht, 289

626. STRUCTURE OF CIRCUMNUCLEAR
REGIONS OF AGNS: Star Formation
and Dense Gas
L.J. Tacconi, A. Eckart, R. Genzel, A. Krabbe,
L.E. Tacconi-Garman
1997, in CO: Twenty-Five Years of
Millimeter-Wave Spectroscopy,
ed. B. Latter et al., Kluwer, Dordrecht, 321

627. CO IN HIGH REDSHIFT GALAXIES
S.J.E. Radford
1997, in CO: Twenty-Five Years of
Millimeter-Wave Spectroscopy,
ed. B. Latter et al., Kluwer, Dordrecht, 327

628. CO (AND OTHER) LINES FROM THE
CLOVERLEAF QUASAR
R. Barvainis
1997, in CO: Twenty-Five Years of
Millimeter-Wave Spectroscopy,
ed. B. Latter et al., Kluwer, Dordrecht, 335

CO IN THE SOLAR SYSTEM
T. Encrenaz
1997, in CO: Twenty-Five Years of
Millimeter-Wave Spectroscopy,
ed. B. Latter et al., Kluwer, Dordrecht, 349

630. NEW DETECTIONS OF METAL-BEARING
MOLECULES IN IRC+10216: FROM
CHEMISTRY TO NUCLEOSYNTHESIS
L.M. Ziurys
1997, in CO: Twenty-Five Years of
Millimeter-Wave Spectroscopy,
ed. B. Latter et al., Kluwer, Dordrecht, 370

631. INFRARED TO MILLIMETER
SPECTROSCOPY AND IMAGING
OF ACTIVE GALACTIC NUCLEI
R. Genzel, D. Lutz, E. Sturm,
L. Tacconi, N. Thatte
1997, in Emission Lines in Active Galaxies:
New Methods and Techniques
eds. B.M. Peterson, F.-Z. Cheng, A.S. Wilson
ASP Conference Series 113, 312

632. SHOCK CHEMISTRY IN BIPOLAR
MOLECULAR OUTFLOWS
R. Bachiller, M. Pérez Gutiérrez
1997, in Herbig-Haro Flows and the
Birth of Low Mass Stars
eds. B. Reipurth and C. Bertout
Kluwer, Dordrecht, 153

633. COLD DUST IN GALAXIES AT
1.2-MM WAVELENGTH
R. Wielebinski
1997, in High-Sensitivity Radio Astronomy
eds. N. Jackson, R.J. Davis
Cambridge University Press, 211

634. OBSERVATIONS OF PLANETARY AND
SATELLITE ATMOSPHERES WITH FIRST
T. Encrenaz
1997, in The Far IR and Submm Universe,
ESA SP-401
ed. A. Wilson
ESTEC, Noordwijk, 39

635. COMETS AT SUBMILLIMETRIC
WAVELENGTHS
J. Crovisier, D. Bockelée-Morvan
1997, in The Far IR and Submm Universe,
ESA SP-401
ed. A. Wilson
ESTEC, Noordwijk, 45

636. THE POTENTIAL OF FIRST FOR THE
EARLIEST STAGES OF STAR FORMATION
P.André
1997, in The Far IR and Submm Universe,
ESA SP-401
ed. A. Wilson
ESTEC, Noordwijk, 51

THE ABUNDANCE OF WATER VAPOUR IN
THE INTERSTELLAR MEDIUM
J. Cernicharo
1997, in The Far IR and Submm Universe,
ESA SP-401
ed. A. Wilson
ESTEC, Noordwijk, 91

FAR-IR AND MM PROPERTIES
OF QUASARS
P. Andreani, A. Franceschini, G.L. Granato
1997, in The Far IR and Submm Universe,
ESA SP-401
ed. A. Wilson
ESTEC, Noordwijk, 133

PRIMORDIAL MOLECULAR LINES
WITH FIRST
P. Encrenaz, R. Maoli, M. Signore
1997, in The Far IR and Submm Universe,
ESA SP-401
ed. A. Wilson
ESTEC, Noordwijk, 145

OBSERVATIONS OF THE HOT GAS IN
CLUSTERS OF GALAXIES WITH DIABOLO
THROUGH THE SUNYAEV-ZEL'DOVICH
EFFECT
F.-X. Désert, M. Giard, A. Benoit
1997, in The Far IR and Submm Universe,
ESA SP-401
ed. A. Wilson
ESTEC, Noordwijk, 259

641. OUTFLOW OF MOLECULAR GAS IN
THE NUCLEI OF BARRED
STARBURST GALAXIES
H. Wozniak, T. Contini,
S. Considère, E. Davoust
1997, in The Far IR and Submm Universe,
ESA SP-401
ed. A. Wilson
ESTEC, Noordwijk, 343

9. ANNEX III - IRAM Executive Council and Committee Members, January 1997

EXECUTIVE COUNCIL

Centre National de la Recherche Scientifique	J.-F. Minster G. Debouzy A. Baudry (President)
Max-Planck-Gesellschaft	R. Genzel W. Hasenclever (Vice-President) K. Menten
Instituto Geografico Nacional	M. Garcia Perez J. Gomez Gonzalez A. Barcia Cancio

SCIENTIFIC ADVISORY COMMITTEE

V. Bujarrabal
D. Despois
A. Eckart
E. Falgarone
J. Martin Pintado (Chairman)
T.G. Phillips
F. Viallefond
R. Wielebinski (Deputy Chairman)
A. Witzel

PROGRAM COMMITTEE

J. Alcolea
J. Black
F. Casoli
R. Chini
A. Fuente
U. Klein (Chairman)
Th. Montmerle
F. Palla

AUDIT COMMISSION

C.N.R.S.	J.-F. Messin A. Etchegaray
M.P.G	A. Bohndorf W. Keinath

The comet Hale-Bopp photographed by A. Rambaud - IRAM, Plateau de Bure.

IRAM ADDRESSES

Institut de Radio Astronomie Millimétrique
Domaine Universitaire, 38406 St Martin d'Hères, France -
Tél.: +33 476 82 49 00 - Fax: +33 476 51 59 38
E-mail address: username@iram.fr
homepage: http://iram.fr

Institut de Radio Astronomie Millimétrique
Observatoire du Plateau de Bure, 05250 St Etienne en Dévoluy, France
Tél.: +33 492 52 53 60 - Fax: +33 492 52 53 61

Instituto de Radioastronomía Milimétrica
Avenida Divina Pastora 7, Núcleo Central, 18012 Granada, España
Tél.: +34 958 22 66 96 - Fax: +34 958 22 23 63
E-mail address: username@iram.es
homepage: http://www.iram.es

Instituto de Radioastronomia Milimétrica
Estación Radioastronomía IRAM-IGN del Pico Veleta, Sierra Nevada, Granada, España
Tél.: +34 958 48 20 02 - Fax: +34 958 48 11 48

IRAM Partner Organisations

Centre National de la Recherche Scientifique - Paris, France
Max-Planck-Gesellschaft - München, Bundesrepublik Deutschland
Instituto Geografico Nacional - Madrid, España