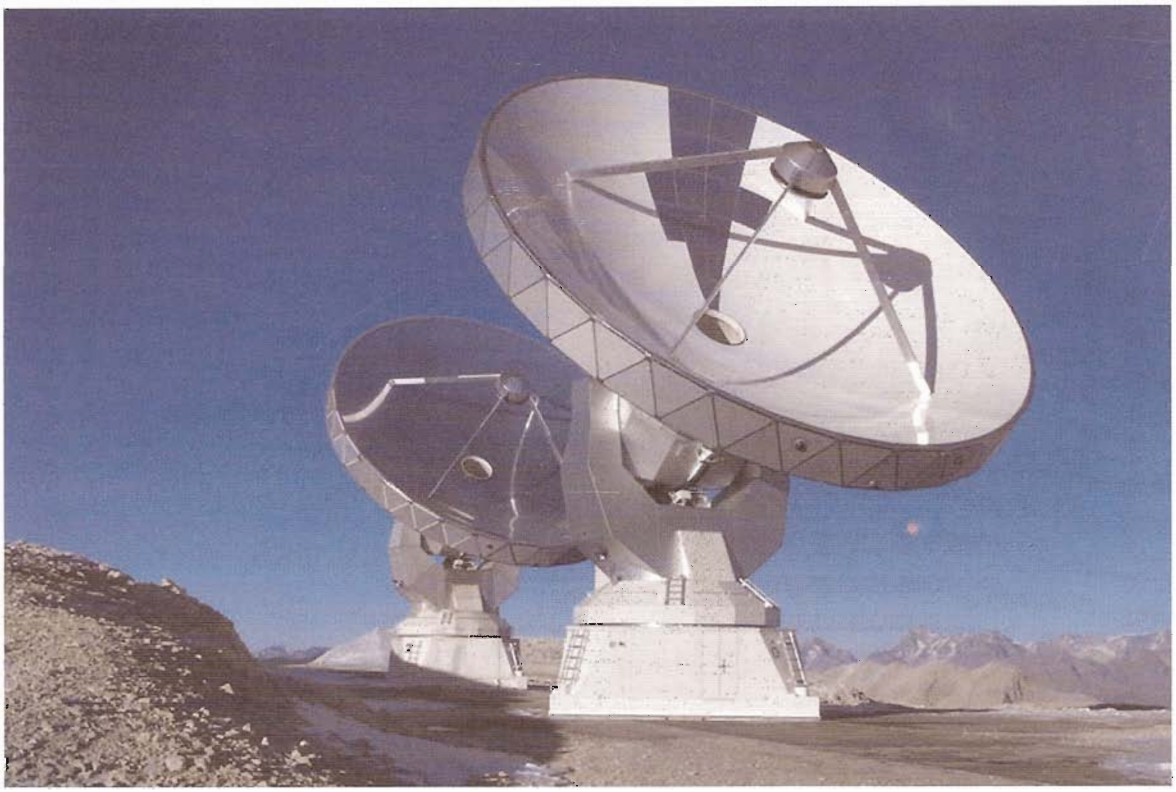
IRAM 2001



ANNUAL REPORT

Front Cover : In December 2001 the 6^{th} antenna was fully assembled and equipped, and ready for the first astronomical tests. Within a few weeks this antenna was fully integrated into the Plateau de Bure interferometer which now routinely operates as a 6-element array. The surface of the antenna is mostly made up of refurbished carbon-fibre panels, except for a few panels in the upper part of the antenna. The reflecting foil which originally covered the carbon fibre panels has been removed. A thin layer of a conductive emulsion paint has been put instead, protected by a second layer of white paint. For details see Chapter 5. (Photograph taken by R. Neri, IRAM)

ANNUAL REPORT

2001

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1. INTRODUCTION

The observing capabilities at both IRAM Observatories have been significantly enhanced in 2001: at the 30m-telescope HERA (**He**terodyne **R**eceiver **A**rray) has successfully been installed and commissioned, a multibeam heterodyne receiver with currently 9 beams which will be extended to 18 beams in the near future, and at the Plateau de Bure Interferometer Antenna 6 got completed and successfully integrated into the array which now offers 15 simultaneous baselines and a total surface area of 1060 square meters.

Work on Antenna 6 had started in 1999. It was stopped after the two terrible accidents that struck the Plateau de Bure Observatory in July and December of 1999, when first the cable car and then a helicopter crashed. Since that time, the observatory was operated in a restricted mode implied by the difficulties to access the site. This situation still prevails. Access remains limited to either helicopter or ground transport, both executed with a maximum of precautions, in which the weather conditions play a decisive role. However, after an initial period when safeguarding the installations with a minimum size team was the top and only priority, we have developed towards a scheme where we could sufficiently increase the number of people working at the observatory in order to resume the observations and to support the necessary maintenance and repair work. In addition, we can allow small teams from subcontractors to work on special projects if they agree to access the Plateau by ground transport and on foot through the so called "fenetre", a mountain slope between 2400 and 2500m, led by a guide.

The completion of Antenna 6 in 2001 would not have been possible without the readiness of the IRAM team and teams from ALSTOM and COMAG to work under these special conditions. As described in more detail later, the assembly work was successful, and the antenna started to perform regular observations after a very short commissioning period.

The complexity of the current operational mode on the Plateau de Bure, and the wish to nevertheless execute not only scientific observations but a variety of additional tasks, led to the creation of a special organizational unit in Grenoble, the "Cellule Bure". One of the aims is to offer a permanent point of contact, to centrally organize all transports to and from the Plateau de Bure for people as well as for goods, and to enable close coordination between the different actors involved in the human resource management, the safety management, the technical management, the scientific management, and the handling of subcontractors.

As evidenced in Section 2 of this report, a number of important scientific results have been published in 2001 by the IRAM User Community and IRAM scientists, despite the fact that no scientific projects were carried out at the Plateau de Bure Interferometer during the first 11 months of 2000. As in previous years, extragalactic observations have played a dominant role. The opportunities offered at the 30m-telescope with the current generation of heterodyne receivers and the multibeam bolometers developed by the MPIfR,Bonn and now permanently installed at the telescope, as well as the capabilities of the interferometer are recognized around the world and lead to an increasing number of international scientific collaborations. With the arrival of Antenna 6th, this trend will certainly continue

As in the years before, IRAM scientists, engineers and technicians actively participated in development work for the ALMA project. The topics worked on include the control software, the data acquisition and reduction software, mixer (band 7) and receiver (optics) development work, and work on backend components. Because of IRAM's interest to participate actively also during Phase 2 of the project, as well as in the longer term, a new group for the development of scientific software has been created, and the ADACE project has been advanced (ALMA Data Analysis Center).

With the aim to attract young astronomers, also from institutes which do not yet have a tradition in millimeter-wavelength radioastronomy, IRAM has started a series of summer schools with financial support from the EU. Lectures on single dish observing techniques oriented towards the 30m-telescope will be interleaved every other year with lectures on interferometry oriented towards the Plateau de Bure Interferometer and towards ALMA.

A key concern that remains, of course, is the final choice and the construction of a new transport system to access the Plateau de Bure. In 2001 the CNRS-INSU has been able to significantly advance the technical studies as well as the discussions with the local authorities who strongly support the future scientific exploitation of the Plateau de Bure and want to develop in parallel to attract tourists into the area through two science parc projects, one in the valley, and a smaller one near the Observatory. As a result, the baseline solution is now the construction of a skilift (with cabins) between the skistation Superdevoluy and the top part of the skiing area near a mountain ridge called "Sommarel", tailored to the needs of the commercial exploitation, followed by a horizontal tunnel and a vertical elevator to overcome the final steep slopes of the mountain between 2300 and 2550m with a capacity more tailored to the needs of IRAM. We look forward to seeing the light at the end of the tunnel!

2. HIGHLIGHTS OF RESEARCH WITH THE IRAM TELESCOPES IN 2001

2.1 SUMMARY

Among projects at the IRAM telescopes, done or published in 2001, a few highlights were :

- **High-redshift CO:** Detection of CO in the quasar PSS 2322+1944.
- **High-z dust:** Searches for mm dust emission from high-*z* quasars and Extremely Red Objects.
- **Galaxies:** Molecular gas in tidal dwarf galaxies: evidence for on-going galaxy formation ?
- **Protostar outflows:** An interferometric study of the HH 288 molecular outflow.
- **Shock chemistry:** Chemical stratification in the bipolar flow from the protostar L1157-mm.
- **Galactic cirrus**: Gravitationally bound cores in a high-latitude molecular cirrus cloud.
- **Circumstellar envelopes:** SiO in a huge detached shell in the yellow supergiant IRC+10420.
- **Protoplanetary nebulae:** Highly collimated bipolar outflow from OH 231.8+4.2
- **New molecules**: Detection of iron oxide in Sgr B2 ?
- **Nearby stars:** Clumpy dust in the ring around Vega as evidence for a hidden planet ?
- **Solar system**: A study of the outgassing and breakup of Comet LINEAR (C/1999 S4).

2.2 EXTRAGALACTIC RESEARCH

Detection of CO and dust in the quasar PSS 2322+1944 at z=4.1

The IRAM interferometer has been used to detect the CO(4-3) and CO(5-4) lines in the radio-quiet quasar PSS 2322+1944 at a redshift of 4.1199. With fluxes in both lines of 4 Jy km/s, this is the strongest of the four quasars at redshift > 4 that have now been detected in CO. The dust continuum emission from the source was also detected with the interferometer with a 1.3mm flux of 7.5 mJy (**Fig. 2.1**), in agreement with previous bolometer measurements at the 30m telescope. The apparent far-infrared luminosity of this object is 3 x 10^{13} $L_{\odot}$, or about 3000 (!!) times greater than that of the starburst in the nearby dwarf galaxy M82. The apparent CO luminosity would also indicate a mass of molecular gas of 3 x 10^{11} $M_{\odot}$, also 3000 times that in M82. These high values, plus the exceptionally high flux of this source in the optical, submm- and mm-continuum, plus the fact that optical images show *two* sources with the same spectrum, all suggest this source may be yet another bright quasar highly magnified by gravitational lensing (Cox et al. 2002, A&A, 387, 406).

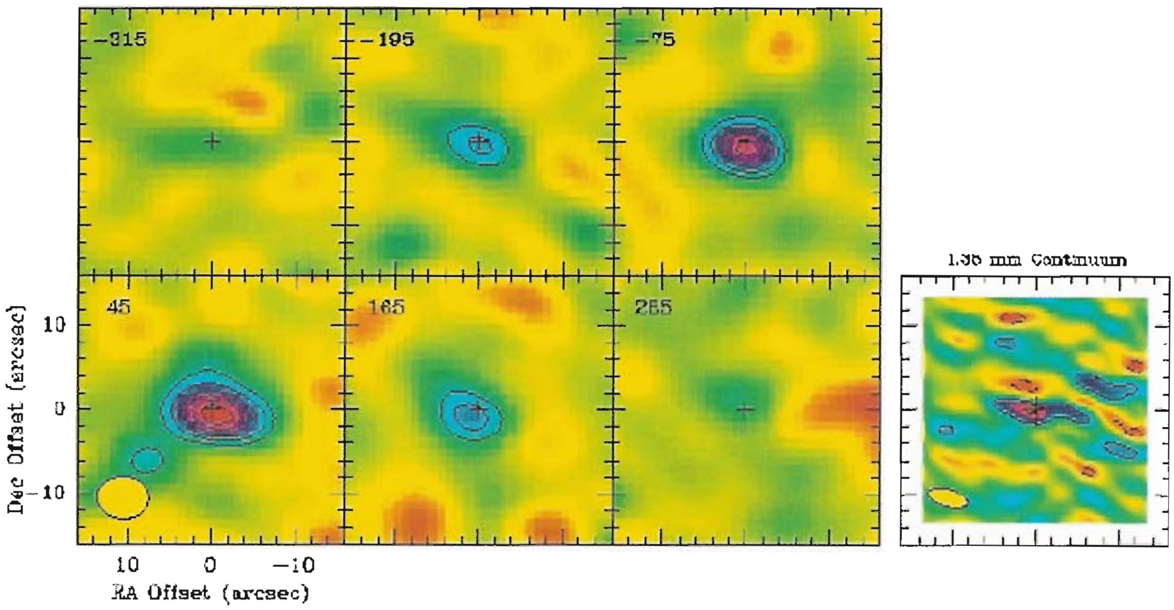


Fig. 2.1: CO and dust in the quasar PSS 2322+1944 at z=4.1. Channel maps of the CO(4-3) line toward the quasar, with velocity offsets relative to z = 4.1199 indicated in the upper left corners. Contours are 1.3 mJy, and the ellipse in the lower left corner indicates the synthesized beam of 6 x 5 arcsec. The lower right inset shows the dust continuum at 1.35 mm, in contour steps of 2 mJy (1.3 σ), detected with a beam of 4.9 x 2.1 arcsec (Cox et al. 2002, A&A, 387, 406).

Survey of dust emission from high-redshift quasars.

The MPIfR bolometer array was used at the 30m telescope to search at 1.2mm for dust continuum emission from 62 quasars at redshift > 3.8 from the Palomar Sky Survey sample, which is a sample of quasars with apparent bolometric luminosities much higher (10^{14} $L_\odot$) than those of the median z>4 quasar population. Naively, the high luminosities of these extremely bright quasars imply that only a billion years after the Big Bang, black holes had grown to sizes of a few billion solar masses. These bright quasars are on the steeply-sloped part of the quasar luminosity function, however, so there is a strong bias toward detecting objects magnified by gravitational lensing. In the new observations with the 30m telescope, 18 sources were detected, and 44 quasars were not, to limits of 1.5 to 4 mJy (3 σ). Nine of the detected quasars have 1.2mm fluxes > 5 mJy. The 30% detection rate is consistent with that in previous 30m surveys of high-z quasars of comparable brightness, and with that in a 30m deep search toward 41 Sloan Survey quasars. Bright quasars at z > 4 with M_B < -27, as in this PSS survey are rare; there is only one such optical quasar every 50 to 100 deg^2 on the sky, so the number of $z > 4$ quasars detectable with mm dust fluxes > 5 mJy is less than one per 100 deg^2. The strongest source detected is PSS J2322+1944 with a 1.2mm flux of 9.6 mJy, making it the second-strongest known mm dust continuum source at $z > 4$ (after BR1202-0725 with 18.5 mJy). This high dust flux, comparable to that of other lensed objects like F10214+4724, APM 08279+5255 and the Cloverleaf quasar, plus the fact that the source is an optical double, and has strong CO lines (see previous paragraph), all suggest that this quasar may be gravitationally lensed as well (Omont et al. 2001, A&A, 374, 371).

Searches for mm dust emission from Extremely Red Objects.

The existence of a population of extragalactic objects with extremely red infrared and optical colours has been known since the late 1980s and early 1990s, when they were first discovered in near-IR searches of blank fields. These Extremely Red Objects (EROs) have R-K colors > 5 mag and K magnitudes fainter than 18. To investigate this population, a survey has been made at millimeter, submm, and cm-radio wavelengths, including observations with the MPIfR bolometers at the 30m telescope. Out of a sample of 27 K-selected EROs, 14 of which comprise a complete sample with $K < 20$ and I-$K > 5$, there was only one tentative detection at 1.2 mm. These results strongly suggest that most of the EROs with $K < 20$ are not ultraluminous starbursts, but rather radio-quiet elliptical galaxies and/or weaker starburst galaxies with luminosities < 10^{12} $L_\odot$ and star formation rates lower than a few hundred solar masses per year (Mohan, Cimatti, Röttgering, Andreani et al. 2002, A&A, 383, 440).

Abundant molecular gas in tidal dwarf galaxies: on-going galaxy formation ?

The 30m telescope and the SEST telescope have been used to detect the CO(1-0) and (2-1) lines in eight tidal dwarf galaxies. Three examples are shown in **Figs. 2.2 and 2.3**. The CO is found at the HI column density peaks, suggesting that molecular gas has formed from atomic gas. What is unusual in these observations is the relatively high CO luminosity, which may be due to the way in which these objects are created. Tidal dwarf galaxies are small galaxies currently forming from debris ejected from disks of large, colliding, spiral galaxies. In such collisions, the centrifugal forces pull out the spirals' outer parts into long tidal tails. The condensations in these tails are thought to have enough mass to be kinematically distinct, self-gravitating entities that will form small, new galaxies --- the "tidal dwarfs." In contrast to forming galaxies in the early universe, these tidal dwarfs contain material that was enriched in heavier elements by the star formation in their parent galaxies. Unlike small, isolated,

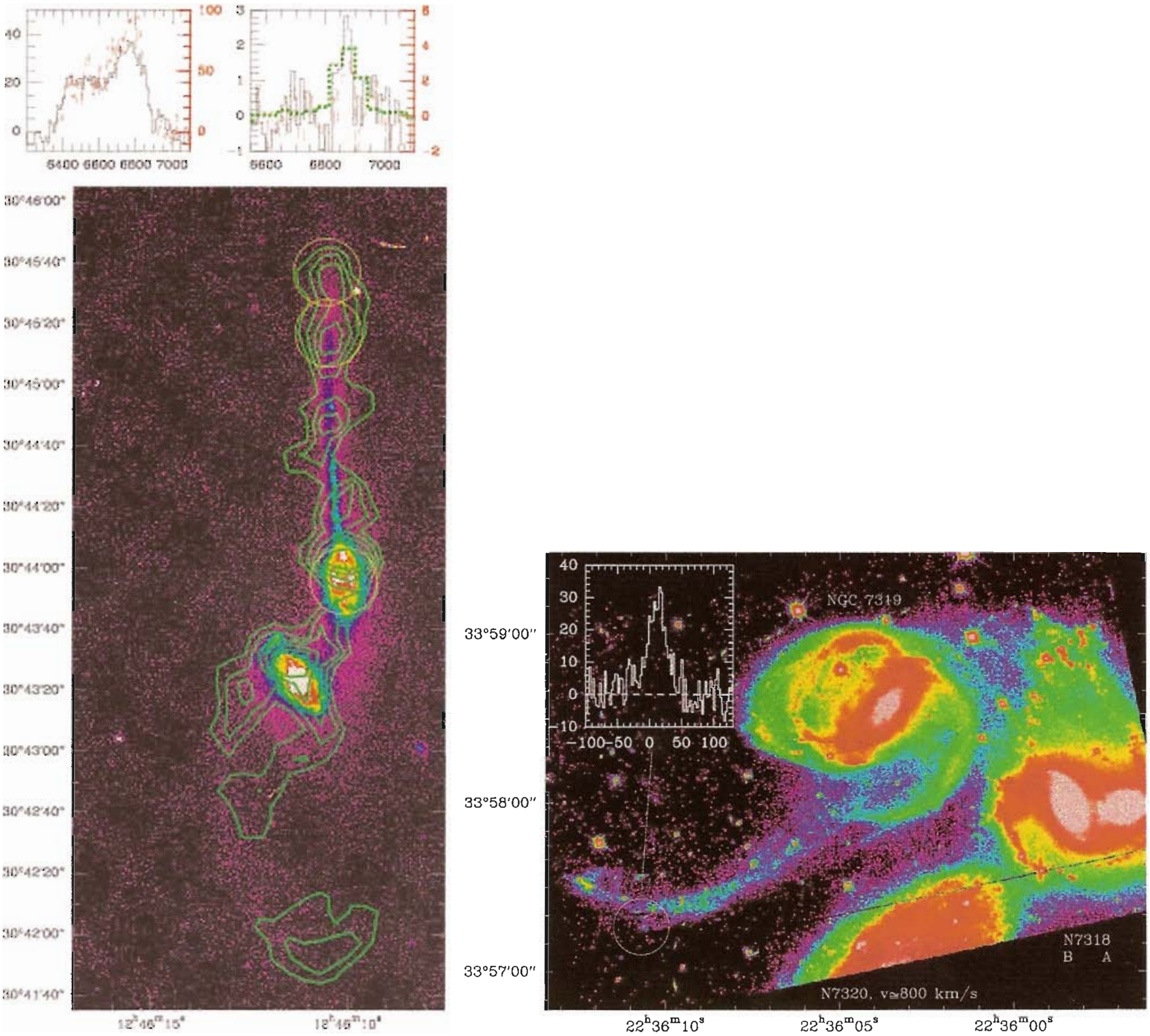


Fig. 2.2: CO in tidal dwarf galaxies. *Left:* The NGC 4676 system, with the R-band image in false colors, H I intensities in green contours. Spectra of the northern spiral (top left inset), and the tidal dwarf (top right inset) are in black for CO(1-0), red for CO(2-1), and green for H I. *Right:* Stephan's quintet, with the HST V-band mosaic in false colors and the CO(1-0) spectrum in the inset. In both images, The yellow circles show the CO(1-0) beam at the positions observed with the 30m telescope (Braine et al. 2001, A&A, 378, 51).

irregular galaxies, which have highly subsolar metal abundances, in tidal dwarf galaxies the metallicity is nearly solar. This may be one of the reasons why the tidal dwarfs have relatively high CO luminosities, about 100 times greater than that of ``standard'' dwarf galaxies of comparable optical luminosity. These high CO luminosities indicate that the tidal dwarfs contain a few times 10^8 solar masses of molecular hydrogen. All the abundant dust dragged out from the parent galaxies must help the atomic hydrogen to combine on grain surfaces to form molecular hydrogen. The dust must also help to shield the molecules against UV radiation that would otherwise break them apart. (Braine, Duc, Lisenfeld, Charmandaris, Vallejo, Leon, & Brinks 2001, A&A, 378, 51).

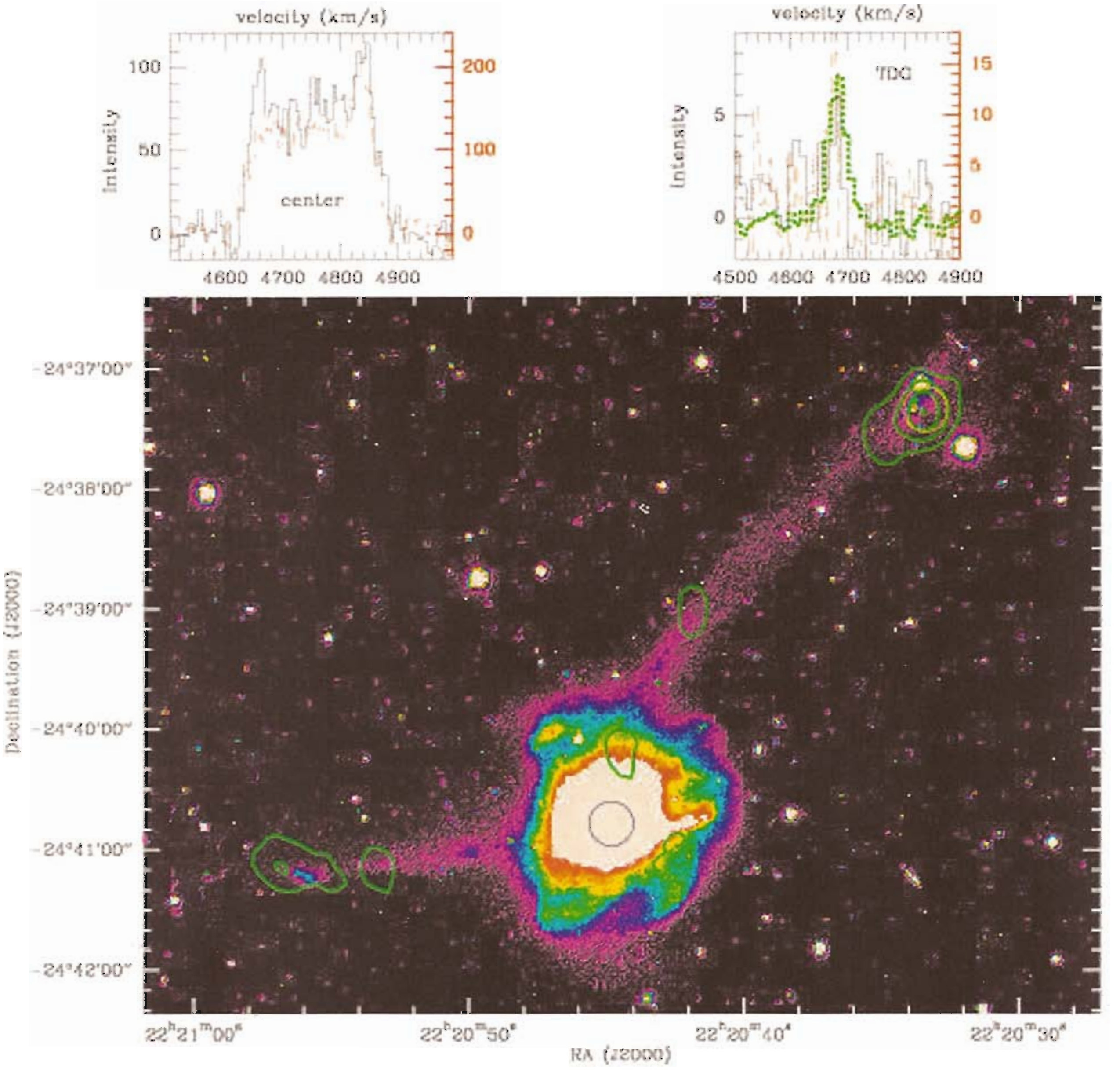


Fig. 2.3: CO in tidal dwarf galaxies. *(continued)* The NGC 7252 system, with the V-band image in false colors, H I in green contours, and inset spectra in the same coding as in the previous figure. The circles at the nucleus and in the northern tidal dwarf show the CO(1-0) beam at the positions observed with the 30m telescope (Braine et al. 2001, A&A, 378, 51).

2.3 STAR FORMATION

An interferometric study of the HH 288 molecular outflow

Outflows of molecular gas from low mass stars are thought to be driven by a jet from a magnetized accretion disk. The matter in the jet creates a bow shock in the molecular-cloud medium and entrains the ambient molecular gas in its wake. To gather data on this process, the IRAM interferometer was used to make an 11-field mosaic map of the CO(1-0) emission in the entire HH 288 molecular outflow, a region 2 pc in extent (**Fig. 2.4**).

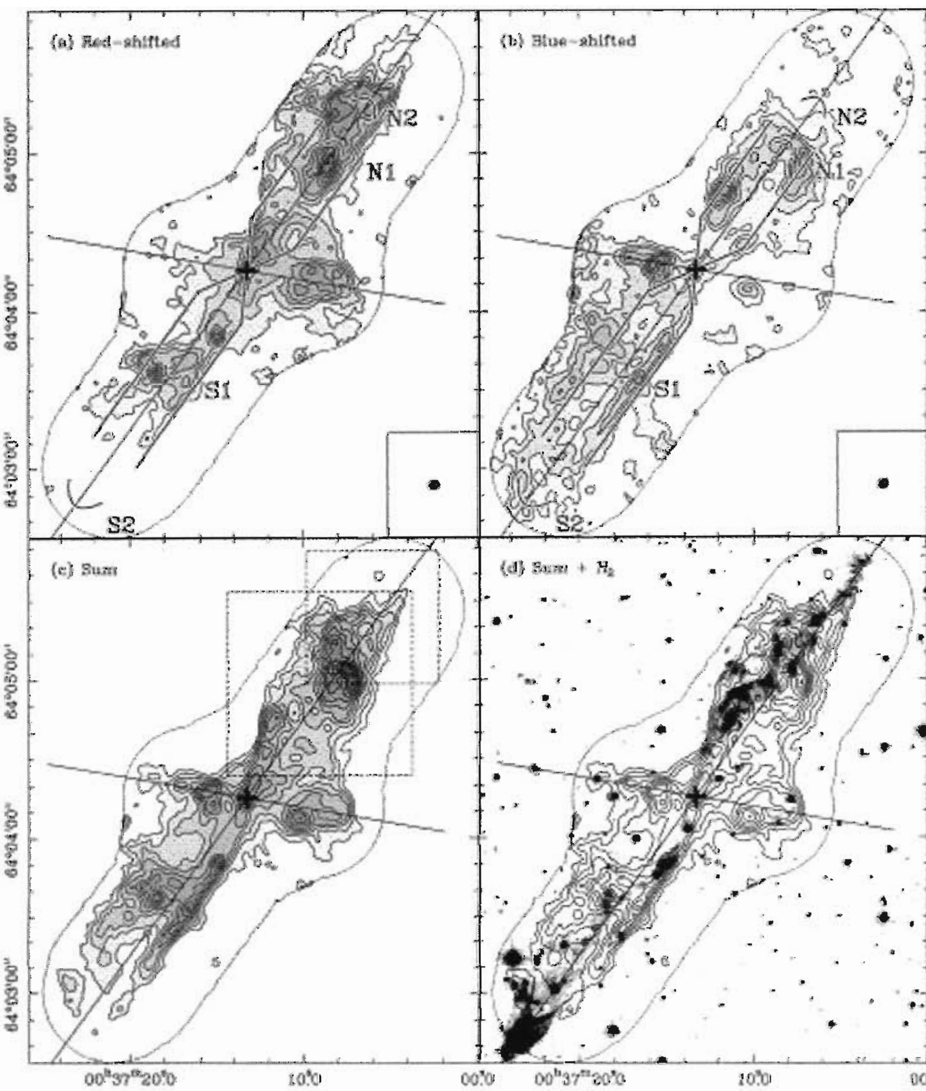


Fig. 2.4: CO emission in the HH 288 molecular outflow. The contours show CO(1-0), mapped with a beam of 3.7″. (upper left): redshifted velocities –26.5 to 22.5 km/s; (upper right): blueshifted velocities –66.5 to –31.5 km/s; (lower left): all velocities; (lower right): overlay of CO on the infrared image in the H_2 line. The straight lines show the axes of the two outflows. (Gueth, Schilke, & McCaughrean 2001, A&A, 375, 1018).

The angular resolution was 3.5", which is 7000 AU at the 2-kpc distance of the protostar. The data were complemented with short-spacing information derived from maps made with the 30-m telescope. The source of the outflow is the infrared source IRAS 00342+6347, a young, intermediate-mass (1 to 20 $M_\odot$) protostar with a luminosity of 500 $L_\odot$, surrounded by a gaseous envelope of 6 to 30 $M_\odot$. The dynamical age of the outflow is a few times 10^4 years. The maps show that HH 288 is a *quadrupolar* outflow --- there are actually *two* outflows, coming from each member of a double star. The small East-West flow has simple kinematics and morphology, while the large North-South flow has several overlapping structures created by successive ejection events. The CO maps show large, collimated, limb-brightened cavities, with high-velocity molecular gas along or near the axis of the outflow. The CO emission coincides with the emission of shocked molecular hydrogen mapped in the near infrared. In general, the internal structure of the molecular outflow in HH 288 resembles that in the low-mass protostars. Hence, as in low-mass protostars, the molecular outflows from intermediate-mass protostars are also formed from ambient gas entrained in the wake of large bow shocks created by the fast-moving jets originating close to the protostar (Gueth, Schilke, & McCaughrean 2001, A&A, 375, 1018).

Chemical stratification in the bipolar flow from the protostar L1157-mm.

The 30m telescope has been used to make a study at 1.3mm, 2mm, and 3mm of several molecular lines in the bipolar outflow from the protostar L1157-mm (**Fig. 2.5**). The CO emission traces the bulk of the outflowing gas in the red and blueshifted lobes, whose *S*-shaped symmetry indicates that the jet is precessing. The characteristics of the CO flow indicate that there have been 3 or 4 independent episodes of mass ejection. Molecules like C_3H_2, N_2H^+ and DCO^+ are seen only in the quiescent medium, and are thus the best tracers of the high-density core or disk surrounding the protostar. Other molecules, like SiO, CH_3OH, H_2CO, HCN, CNH, SO, and SO_2 , are abundant in the outflow lobes, but show strong gradients in intensity along the lobes of the bipolar flow. Multiline observations of some molecules indicate that these gradients are due to an actual stratification in the chemical components of the shocked molecular gas. Shock tracers such as SiO, CH_3OH, and sulphur-bearing molecules appear to be chemical clocks to study the evolution of outflows. Because of the richness of its molecular spatial structure, L1157 can be taken as the prototype of "chemically active" bipolar outflows from young, dust-embedded protostars. (Bachiller et al. 2001, A&A, 372, 899).

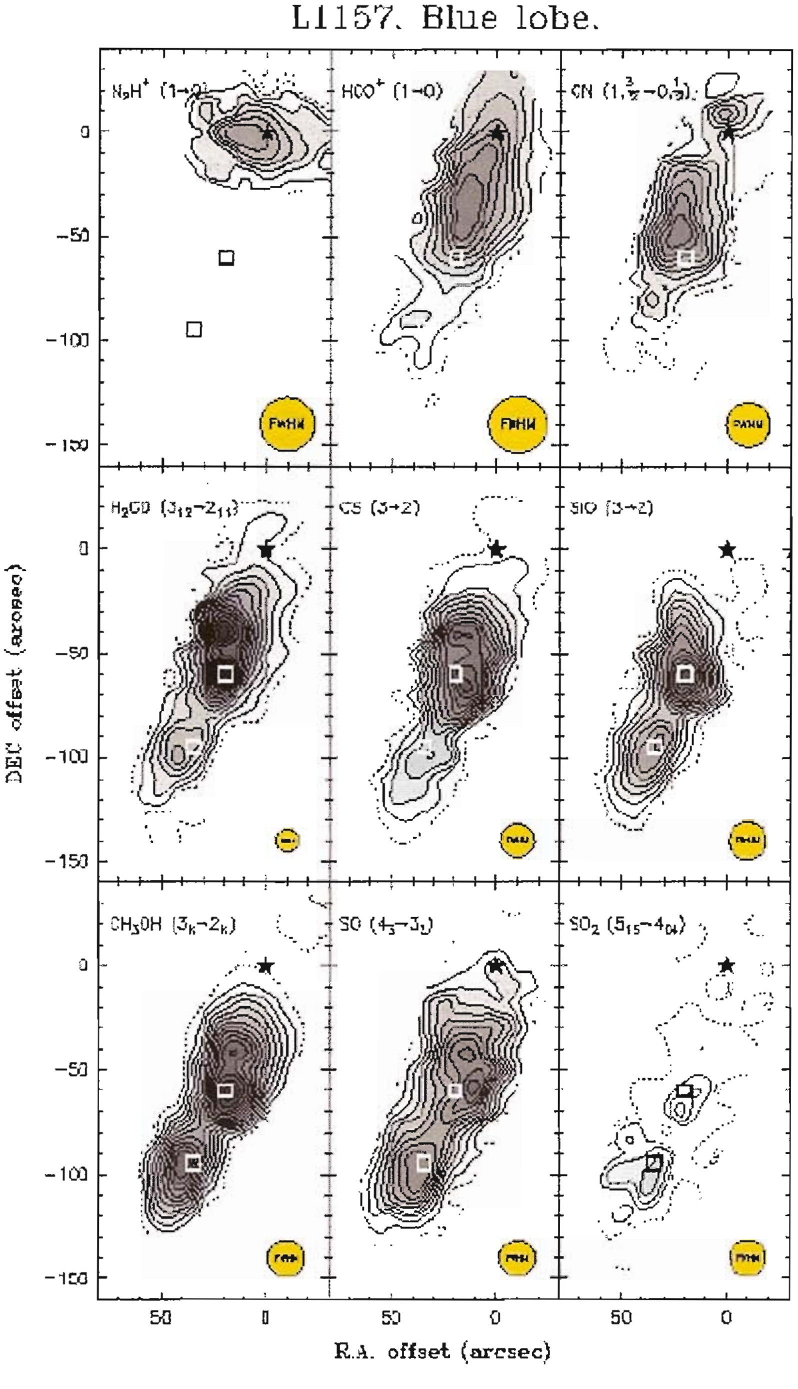


Fig. 2.5: Chemistry and shock waves. 30m-telescope maps of molecules in the south lobe of L1157. The star indicates the protostar L1157-mm, squares show sites of earlier line surveys. The ion N_2H^+ (top left) traces the high-density disk around the protostar. The other molecules trace the chemistry in the flow. The circles in the lower right of each box indicate the telescope beam. (Bachiller et al. 2001, A&A, 372, 899).

Gravitationally bound cores in a molecular cirrus cloud.

Galactic "cirrus" clouds, so named because of their thin, wispy appearance on infrared maps made in the late 1980's with the *IRAS* satellite, have not been considered sites of star formation, because of their low density and turbulent motions that keep them from contracting by their own gravity. In 1999, however, CS emission, a high-density tracer, was detected with the 30m telescope in three dense "cores" in a cirrus cloud at galactic coordinates 123.5+24.9. This cloud is part of the so-called Polaris flare, a large cirrus cloud near the north celestial pole. Stars form in dense cores of molecular clouds, and the CS spectrum of one of the cores in this particular cirrus cloud suggested infalling gas (Heithausen 1999, A&A, 349, L53). New studies of these cirrus cores have now been made at the 30m telescope in the 1.2 mm dust continuum emission and in the cyanoacetylene $HC_3N(10-9)$ line, and with the Effelsberg 100m telescope in the $HC_3N(3-2)$ and (4-3) lines (**Fig. 2.6**).

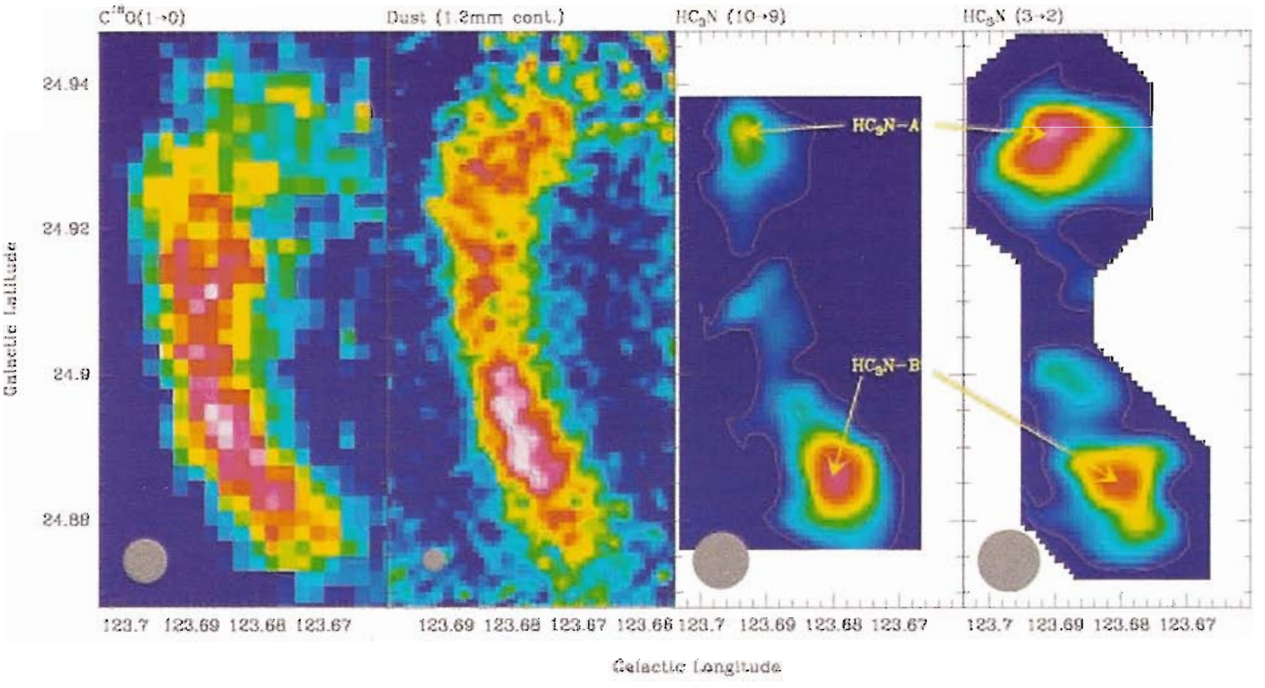


Fig. 2.6: Molecular lines and 1.2mm dust continuum from an *IRAS* cirrus cloud. Comparison of maps of the *IRAS* cirrus filament 123.5+24.9 in $C^{18}O$ (30m map, Falgarone et al. 1998), 1.2mm dust continuum (30m map), and HC_3N line emission (30m and Effelsberg maps). Circles in lower left corners are the beam sizes. The peak dust flux is 11 mJy at 1.2mm. The cloud cores marked HC_3N -A and –B appear to be gravitationally bound. Their sizes are 0.02 pc and their masses are 0.13 and 0.19 solar masses (Heithausen, Bertoldi, & Bensch 2002, A&A, 383, 591).

The 1.2mm dust emission is easily detectable, with a peak flux density of 11 mJy in the 11" beam. Analysis of the molecular lines and the dust continuum show that the two main cores have sizes of about 0.02 pc and masses of 0.13 and 0.19 solar masses. These cores are embedded in a filament extending over 0.18 x 0.03 pc, at an adopted distance of 150 pc. These masses derived from the line and continuum intensities happen to agree closely with the virial masses estimated from the line widths and the core sizes. This unexpected result means the cores are very probably gravitationally bound, and may be able to collapse to form low-mass stars (Heithausen, Bertoldi, & Bensch 2002, A&A, 383, 591).

Detection of iron oxide in Sgr B2 ?

Why haven't iron-bearing molecules been found in the interstellar medium up to now? The usual answer is that refractory elements like sodium, silicon, magnesium, iron, and phosphorus are depleted in molecular clouds, where they form "silicate grains". This means gas-phase silicon, for example, is a million times less abundant in molecular clouds than the solar Si abundance. Silicon is present at low levels in some molecular clouds associated with outflows from protostars, where it can be detected as gas-phase SiO. These molecules are thought to be liberated from dust grains by the high-speed shocks produced by the outflows. If silicon is liberated by shocks, then iron and magnesium should be liberated as well. New observations in October and December 2001 at the 30m telescope finally provide evidence for iron, with a detection of a line tentatively identified as FeO(5-4), in absorption against the free-free continuum of the galactic-center H II region Sgr B2. The iron-oxide absorption agrees well with the radial velocity of the well-known SiO absorption against Sgr B2 (**Fig. 2.7**). An analysis of the line strength suggests the column density of FeO is about 10^{12} cm^{-2}, and that the FeO / H_2 ratio is only 3 x 10^{-11} , a tiny fraction of the solar iron abundance, which is 4 x 10^{-5} relative to hydrogen. One may also compare FeO with SiO: the ratio [FeO / SiO] is only 0.002, which may explain the lack of detections of FeO in the past, and the lack of detections of FeO in any source other than Sgr B2. Why is this? It seems that while iron and silicon are both eroded from dust grains by shocks, iron is much less reactive in the shock and the post-shock gas than atomic silicon. While the molecules OH and O_2 can react at low temperatures with ***silicon,*** their reactions with ***iron*** are endothermic by 1500 and 10000 K, respectively, and can only occur at the high temperatures produced in a shock wave. Hence while all of the sputtered-off silicon may end up in molecules, only a few percent of the iron atoms eroded from dust grains may end up in gas-phase iron oxide (Walmsley, Bachiller, Pineau des Forêts, & Schilke 2002, ApJ, 566, L109).

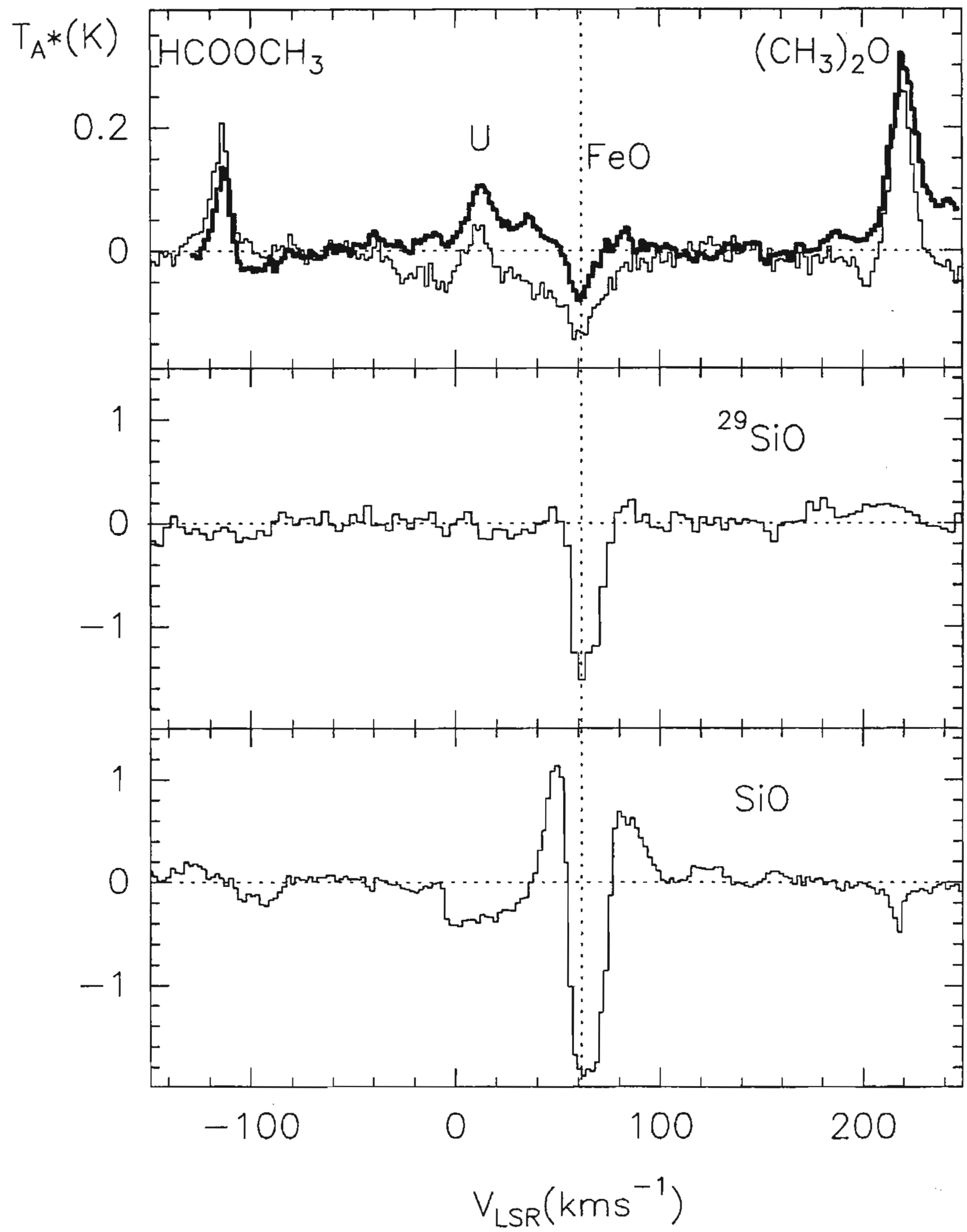


Fig. 2.7: Iron oxide in absorption against Sgr B2 at 153 GHz ? *Top panel*: Tentatively-identified FeO(5-4) absorption line toward Sgr B2M at 153 GHz, measured in October (thin) and December 2001 (thick). *Center and bottom panels*: Lines of ^{29}SiO and ^{28}SiO also measured on the 30m telescope, by de Vicente in 1994. The thin dashed line at 61.5 km/s shows the good agreement of the absorption features in velocity, which is an argument in favour of identifying the new line as FeO (Walmsley, Bachiller, Pineau des Forêts, & Schilke 2002, ApJ, 566, L109).

CIRCUMSTELLAR ENVELOPES

Detection of SiO in a huge detached shell around the yellow "hypergiant" IRC+10420. IRC+10420 is an extremely luminous (7 x 10^5 $L_\odot$) post-red supergiant star at a distance of 5 kpc. It now has a yellow colour (spectral type F or possibly type A), because it is evolving rapidly into a star with a higher surface temperature, and loosing mass at the enormous rate of 5 x 10^{-4} $M_\odot$ per year. The star is surrounded by a dense circumstellar envelope detected in the infrared and optical over an extent of 15", that has been ejected over the past 12,000 years. This oxygen-rich star is well known as a source of OH masers, which are in a shell of radius 1". The star is also known from single-dish observations to have thermal, v=0, SiO(2-1) emission. In nearly all O-rich AGB stars, such thermal SiO emission is observed only from the very inner regions of the envelope, within a radius of 10^{15}cm of the star, where the gas is still above the 2000-K sublimation temperature of silicate grains. Farther out, the temperature drops, and the silicon-bearing molecules all go into solid grains; SiO is never seen in far-out, ``detached" shells around late-type stars. New observations of IRC+10420 with the IRAM interferometer however, show a very surprising result: the thermal SiO line does indeed come from a huge, hollow, detached shell with a radius of 10^{17}cm (0.5″) that is expanding at 35 km/s (**Fig. 2.8 and Fig. 2.9**). This unexpectedly high abundance of gaseous SiO far from the star is difficult to explain. Because SiO can be knocked out of grains by high-temperature shocks, it is tempting to speculate that relatively recently, the star has rapidly ejected new material into the more slowly moving, pre-existing circumstellar envelope, and that the new matter has shocked the gas farther out, releasing the SiO from the dust grains (Castro-Carrizo, Lucas, Bujarrabal, Colomer, & Alcolea, 2001, A&A, 368, L34).

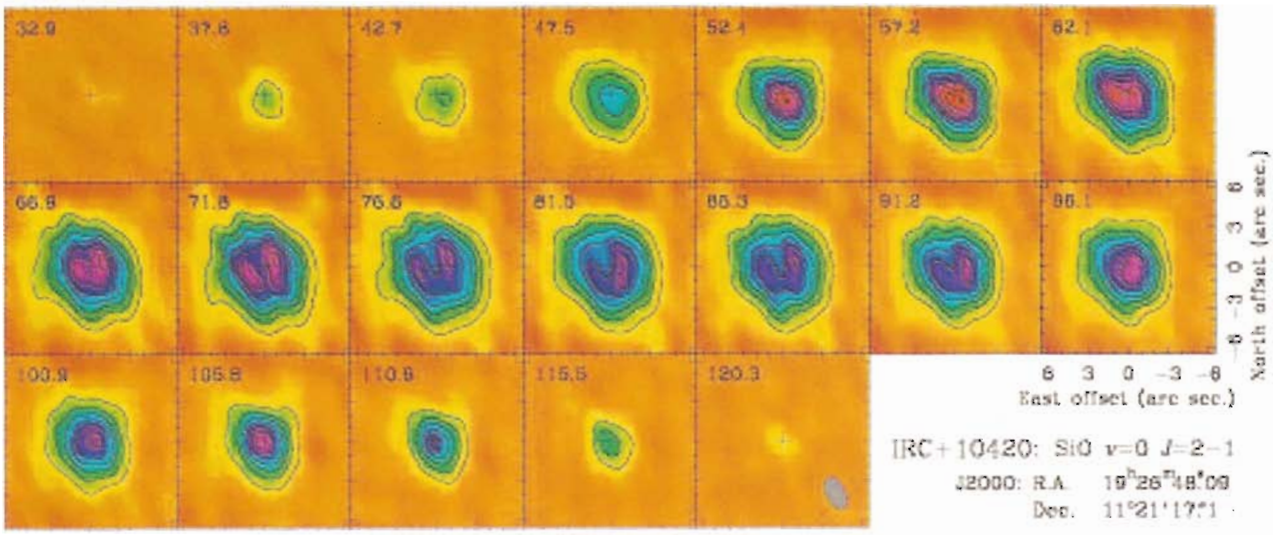


Fig. 2.8 Thermal SiO in a huge detached shell around IRC+10420. Interferometer maps of the star in the SiO v=0, J=2-1 line in 4.9 km/s velocity channels. Model fits can reproduce the central minimum if the SiO is in a hollow, expanding shell with a radius of 10^{17} cm.

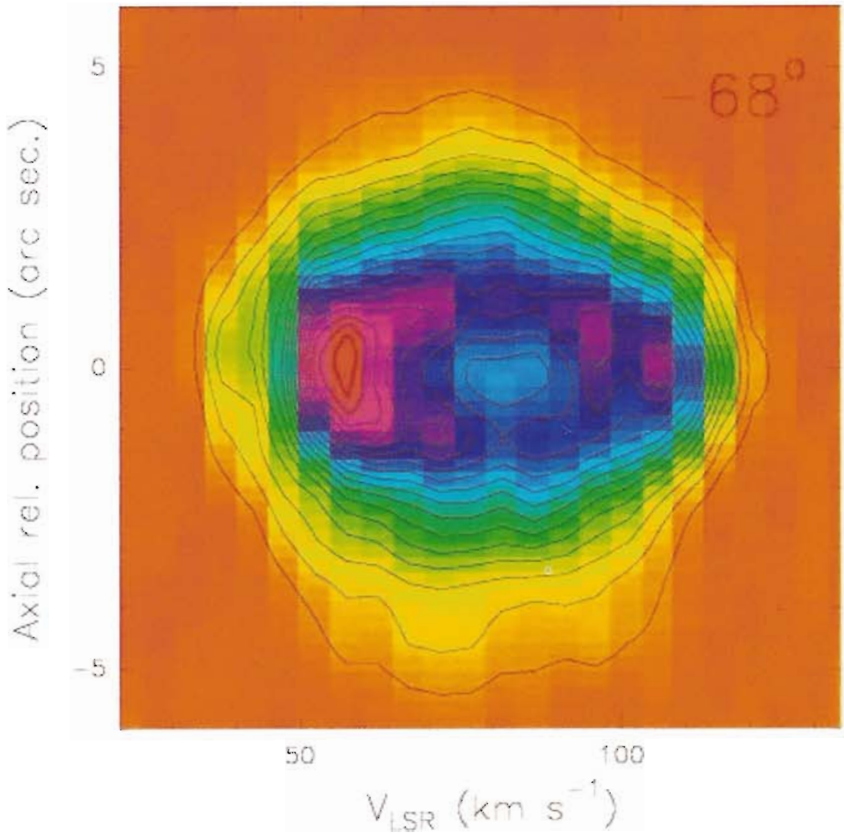


Fig. 2.9 Thermal SiO in a huge detached shell around IRC+10420. Position-velocity diagram across the shell; the model fit indicates a shell expansion velocity of 35 km/s (Castro-Carrizo, Lucas, Bujarrabal, Colomer, & Alcolea, 2001, A&A, 368, L34).

The highly collimated bipolar outflow from the protoplanetary nebula OH 231.8+4.2

OH 231.8+4.2 is a well-known bipolar nebula around an evolved star, which in IR and visible light extends over 1′ on the sky, due to scattering of the star's light by dust grains in the nebula. New CO(1-0) and (2-1) maps from the IRAM interferometer with a 1″ beam show that the CO coincides with the near-IR scattered light, and that the outflow is highly collimated, with a length-to-width ratio of 20-to-1 in the southern lobe. The CO maps indicate low gas temperatures, from 35 K in the centre to 8 K in the outer clumps. Most of the nebular mass (0.64 $M_\odot$) is in the centre, flowing out at 40 km/s. The rest (0.3 $M_\odot$) is in the two high-speed lobes flowing out along the nebular axis. The velocity increases with distance from the star, reaching a top speed of 430 km/s. This gives the outflow a very high kinetic energy, 3.4 x 10^{46} erg, about 100 times greater than could possibly be provided by radiation pressure from the star. This conclusion holds for many other bipolar flows from protoplanetary nebulae (see the extensive study by Bujarrabal et al. 2001, A&A, 377, 868). Since radiation pressure cannot explain the bipolar flow, it is likely that the energy actually comes from gravity. Energy released by accretion onto the stellar surface may be transformed via rotating magnetic fields into an axially collimated flow in a process similar to that in young stellar objects and active galactic nuclei (Alcolea et al. 2001, A&A, 373, 932).

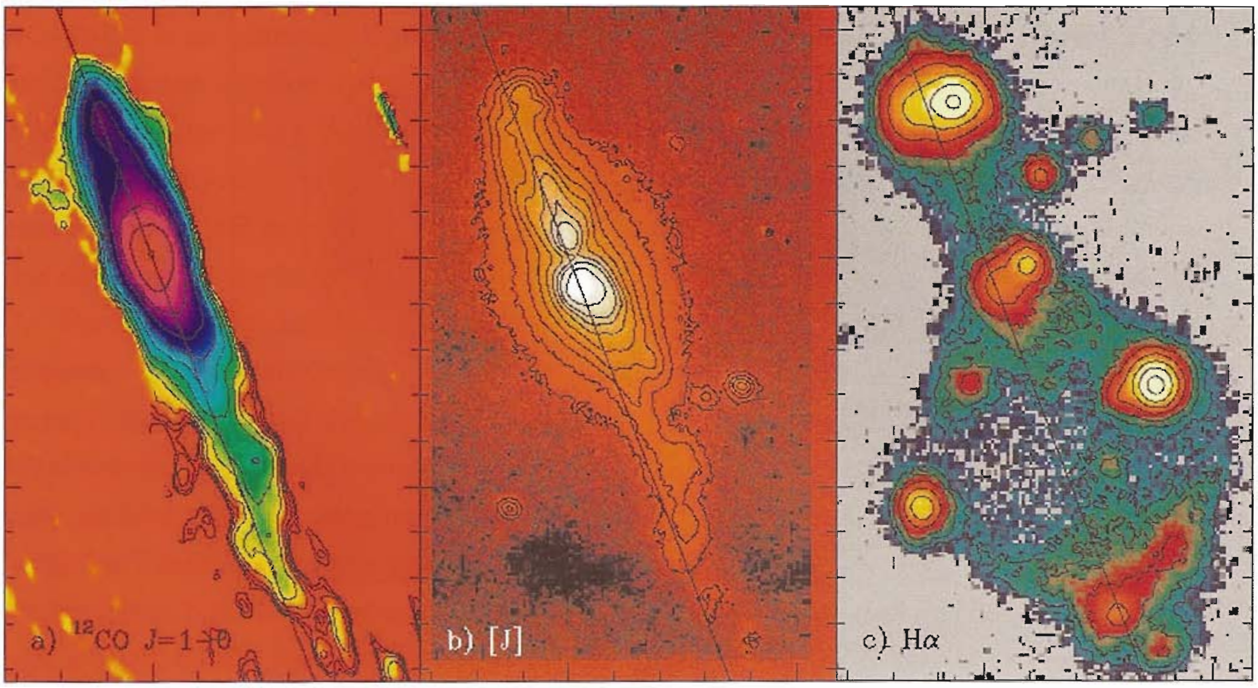


Fig. 2.10: Highly collimated bipolar outflow from the protoplanetary nebula OH 231.8+4.2: *a) Left:* The cool molecular gas in CO(1-0) integrated emission, *b) middle:* J-band light, scattered by dust, *c) right:* hot, shock-excited gas, emitting in the Hα line. North is up, east is left, tick marks are every 4″, and the diagonal line is the axis of symmetry of the nebula (Alcolea et al. 2001, A&A, 373, 932).

Clumps in the dusty debris around Vega as evidence for a hidden planet?

Dust around the nearby star Vega was discovered with the *IRAS* satellite in 1984 as a far-infrared flux greatly in excess of the photospheric emission. Recent maps of Vega and other dust-excess stars at 850µm with the James Clerk Maxwell Telescope (JCMT) have revealed mysterious emission peaks offset from the stars. Current mm arrays can easily study Vega, because it is high in the northern sky, it is only 7.8 pc away, and its dust disk appears to be viewed pole-on. A study with the Caltech mm interferometer (Koerner et al. 2001 ApJ, 560, L181) resolved several dust peaks in what may be Vega's circumstellar ring. New, higher-sensitivity observations with the IRAM interferometer at 1.3mm easily detect the 1.7mJy emission from the photosphere of Vega and also detect two knots of dust emission offset by 60 and 75 AU from the star, at positions similar to those of the main peaks in the Caltech map. The two clumps account for a large fraction of the dust emission around Vega. Model simulations of dust interacting with a Jupiter-mass planet on an eccentric orbit suggest that such a planet may indeed create a pair of orbiting dust clumps, where dust is temporarily entrained at orbital resonance points, which are not co-linear with the star, with one dust clump slightly farther from the star than the other. If such a planet does exist around Vega, it could be as bright as 18th magnitude in H band, and potentially accessible to direct imaging (Wilner et al. 2002 ApJ, 569, 115).

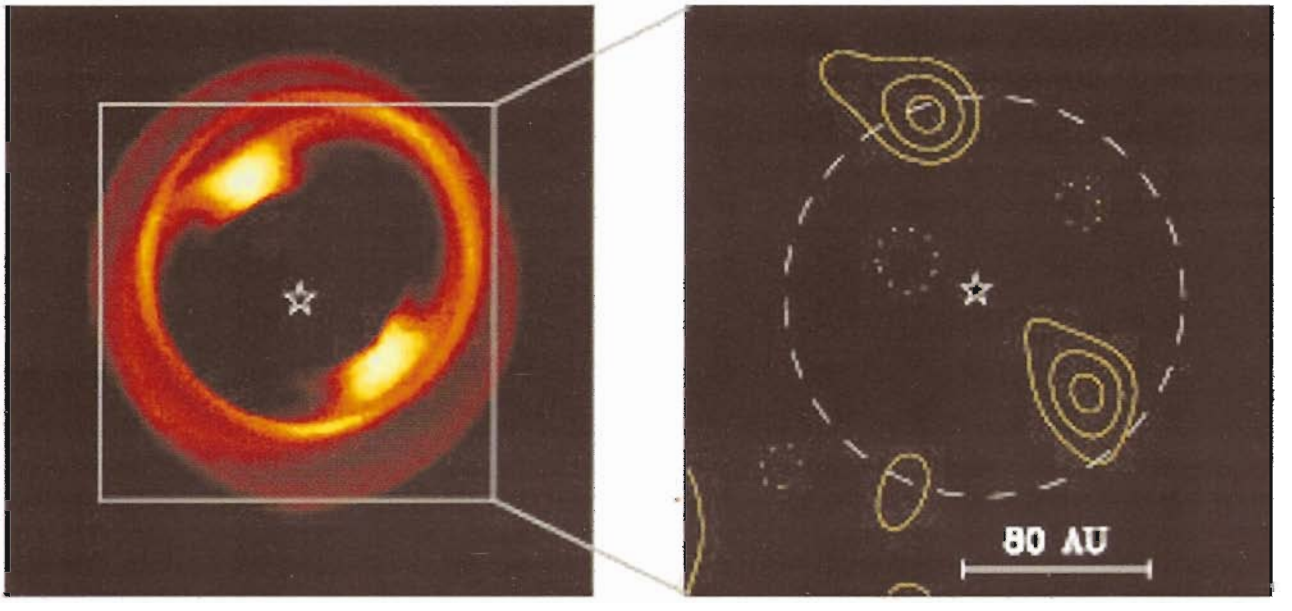


Fig. 2.11: Structure in the dusty debris around Vega. *Left:* Computer simulation of 1.3mm emission from dust in a disk around Vega, influenced by a hypothetical 3-Jupiter-mass planet, radiation pressure, and Poynting-Robertson drag. The dust becomes temporarily trapped in two lobes that are resonances with the presumed planet. *Right:* 1.3mm observations with the IRAM interferometer, tapered to 4″ resolution. Contour levels are ±1, 1.7, and 2.3 mJy. The 1.7mJy emission from the photosphere of Vega has been subtracted (Wilner et al. 2002 ApJ, 569, 115).

2.5 SOLAR SYSTEM

Outgassing of Comet LINEAR (C/1999 S4) during its disruption .

The nuclei of comets are porous, fragile objects made up of ices and dust, which sometimes split up into several fragments that then disintegrate into small debris. One of these was comet C/1999 S4 (LINEAR), a long-period comet which approached to within 0.37 AU of the Earth just a few days before its perihelion on 26 July 2000.

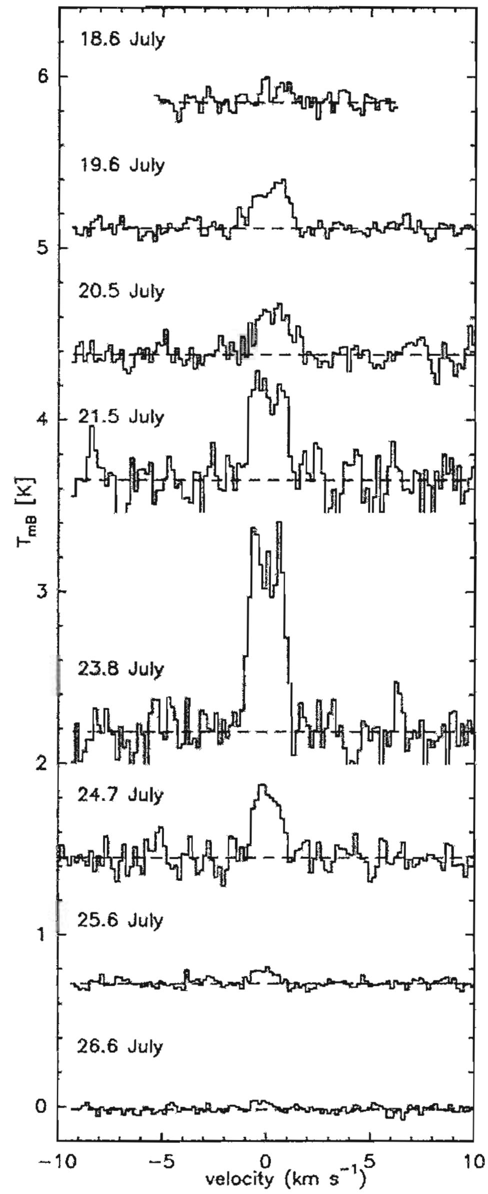


Fig. 2.11: HCN outburst in Comet LINEAR S4 during its disruption. The HCN(3-2) line at 265.9 GHz observed at the 30m telescope, 18 to 26 July 2000. Horizontal axis is radial velocity relative to the comet, vertical axis is main-beam T_b. Over July 18 to 23, the outgassing from the disintegrating comet increased by a factor of ten, and then died out over the next three days.

During this time the comet was observed daily with the IRAM 30m and other mm and submm telescopes, which were fortunate to witness the spectacular runaway breakup of the nucleus, that led to its complete disappearance. An analysis of the outgassing activity of Comet Linear during this event has now been published. Five molecules were detected in the mm/submm bands (HCN, HNC, H_2CO, H_2S, and CS). Between July 18 and July 23, the outgassing from the disintegrating comet increased by a factor of ten, and then rapidly decreased over the next three days.

A possible interpretation is that in the 5 days after July 18, the disruption of the nucleus increased the area of exposed icy material by a factor of ten, leading to the loss of about 10^9 kg of material, which is the mass that would be contained in an icy sphere with a diameter of 200 to 600m. This suggests that the nucleus of Comet LINEAR S4 had already become rather small by the time of this final passage near the Sun. The decrease in the HCN production rate between July 24 and 27 can be explained by the sublimation of the remaining fragments, by then only about 40 cm in size, which could survive in the solar heat only for about 3 days. The abundances, relative to water, of HCN, HNC, H_2CO, H_2S, and CS are all consistent with those measured in other comets, while methanol (CH_3OH) and carbon monoxide (CO) were deficient. Given the small size of the nucleus, the CO may have already sublimated in late 1999, when the comet was still at 4 A.U. from the Sun, before the final breakup at perihelion on July 26, when the comet got within 0.77 A.U. of the Sun. (D. Bockelée-Morvan, R. Moreno, et al. 2001, Science, 292, 1339). Continuum observations were also made at the 30m telescope at the same time as the spectral-line observations, with the MAMBO bolometer array at 1.2mm. The continuum detections prior to 23 July indicate a radio photometric diameter of 4.7 km, with a nucleus of about 0.9 km, which makes Linear S4 the smallest comet ever detected at radio wavelengths. After the breakup on 23 July, the 1.2 mm continuum emission was no longer detected, supporting the implication of optical observations that the dust production was greatly reduced (Altenhoff, Bertoldi, Sievers, Thum, et al. 2002, A&A, 391, 353).

3. Pico Veleta Observatory

3.1 Staff Changes

The backend group in Granada has been merged with the telescope group. Salvador Sánchez is now working with Juan Penalver while Gilles Butin returned to Grenoble, joining the receiver group. Salvador Sánchez continues as the contact person for backend related questions and for VLBI. Teresa Gallego was hired as a telescope operator. Our cooperant/assistant astronomer Pierre Hilly Blant left IRAM.

3.2 30-m Telescope Operation

Operation in 2001 was generally smooth. The winter 2000/2001 had a lot of bad weather while during the fall of 2001 the observing conditions were excellent. As shown in Fig. 3.1, almost 2/3 of the available time could be used for observations. Figure 3.2 is a breakdown of the observing time in hours.

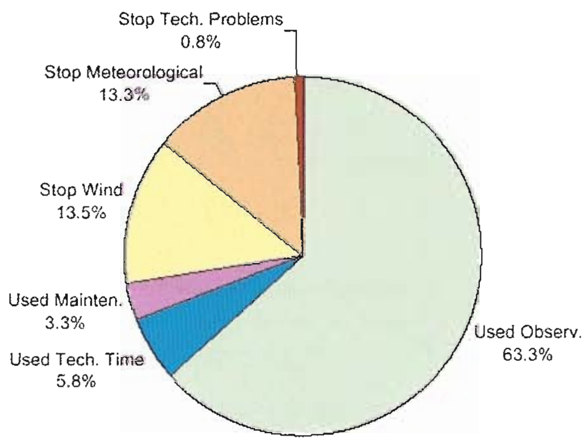


Fig.3.1: Distribution of the total telescope time for the year 2001

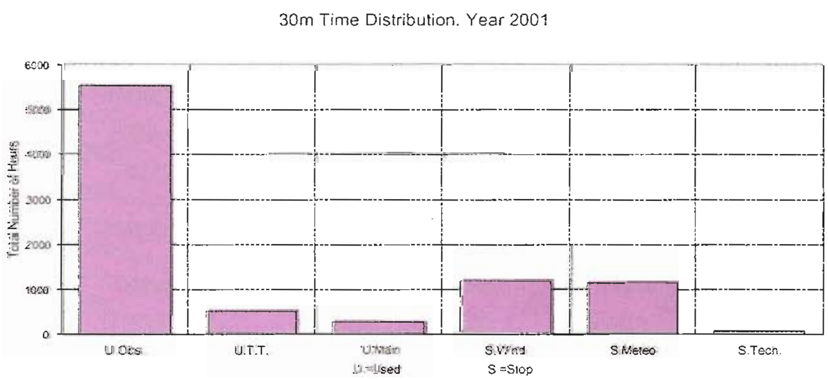


Fig. 3.2: Distribution of the total telescope time in 2001 in hours.

In order to increase the efficiency of the telescope, a flexible observing scheme was introduced. In this scheme, several projects with different needs for atmospheric conditions are pooled and projects are observed according to the actual weather conditions. This helped in particular to increase the success rate of those bolometer projects that need the highest achievable sensitivity, but also projects with less demanding weather constraints increased their share of observing time. During the winter of 2000/2001 and in the summer of 2001 flexible observing was organized on a voluntary basis by those groups who wanted to participate in pool observing. During the winter of 2001/2002 virtually all bolometer projects were observed in a pool organized by IRAM. Backup projects were less demanding bolometer projects and also heterodyne projects. It is too early to make a final evaluation of the increase in efficiency during pool observations, but it seems to go up by at least 50%.

Many projects in a pool were carried out by IRAM staff or visiting astronomers who happened to be at the telescope, following the instructions of the PIs. IRAM staff astronomers checked the quality of all data observed, archived the data and forwarded them to the PIs. A database was used to do the accounting of the observing time and to decide the sequence of the projects to be observed, taking into account the scientific rating, the weather conditions, and technical requirements.

As in previous years, the main effort of the technical groups has focused on maintenance issues. In practice this means to help with the daily observing and operation problems, to perform the necessary preventive maintenance of the equipment, to repair broken equipment, and to support the installation of special equipment for particular projects

A second engineer was incorporated into the telescope group. This allows to have always one engineer at the observatory during weekdays. During the weekends and holidays one antenna engineer is on standby. A similar standby service for weekends has been established for the computer group and for the receiver group. In case of technical problems, the engineer can be consulted by mobile phone and be at the telescope within a few hours if necessary.

Redundant sensors (encoders) were installed to read the six subreflector spindle positions. Now failures of spindles can be easily identified. This put an end to the unpredictable effects that wrong readings produced in the pointing, a problem from which several observers had suffered during previous months. Fig. 3.3 shows one of the six subreflector spindles with the mechanical installation of both encoders, old and new. The upper one (metal color) is the new one.

The antenna motor brakes are now controlled by new electronic modules. The old modules caused typically two failures per year. The new modules have so far worked flawlessly.

The programmable controller of the SCU (Servo Control Unit) has been modified with new features that give more reliability when the stow pins for elevation or azimuth are inserted or removed, in particular after strong winds when the antenna is displaced and blocking the pin.

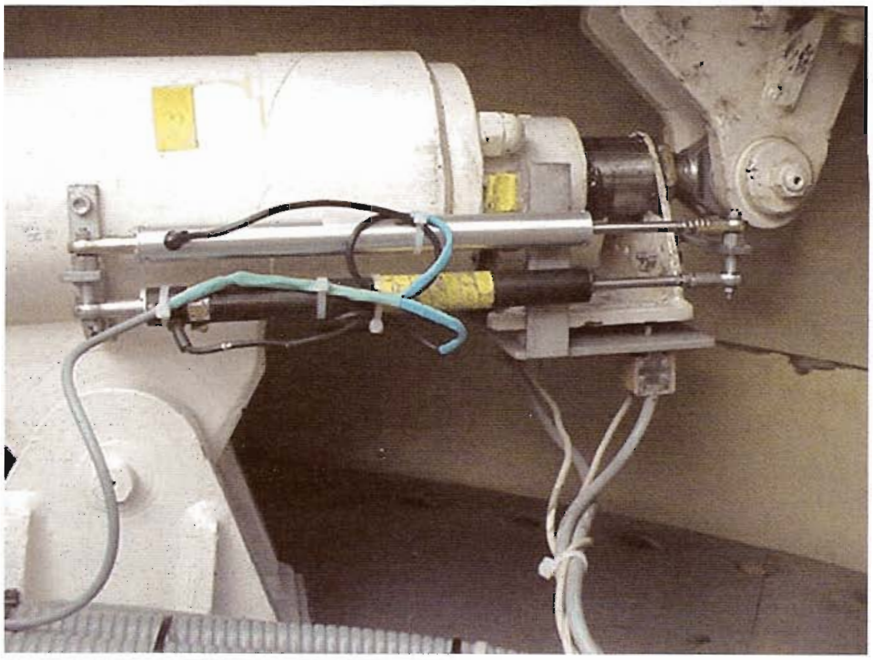


Fig. 3.3: New encoder for the spindles controlling the subreflector. Below an old encoder, above the a newly installed model.

New facilities have been implemented into the subreflector-wobbling system during the heavy maintenance period. The servoamplifiers of the wobbling system have been equipped with protected varistors. Now the air flow to cool the shakers, the subreflector de-icing and the subreflector temperature can all be monitored remotely, without the necessity of physical access to the prime focus.

Broken elements of the de-icing system of the backstructure of the antenna have been repaired by the IRAM staff.

3.3 Receivers

Since May 2001 the IRAM 30-meter telescope is equipped with a heterodyne multibeam receiver. The long awaited nine channel HERA instrument was installed without major problems and commissioned shortly thereafter. Before shipment to the telescope, the receiver had been tested and pre-tuned at six of the main astronomical lines inside the 230 GHz atmospheric window. Full frequency coverage of the 1.3 mm band will soon be available.

Contrary to the previous receivers, the HERA instrument uses a water-cooled cryogenerator. A special set-up, including an internal water cooler and external heat exchanger on top of the receiver cabin, had been prepared.

Fig. 3.4: HERA, a 9 pixel receiver for 230 GHz spectroscopy. In a second step it will be equipped with 18 channels.

Switching from standard SIS receivers to the HERA instrument is very easy. The switching of mirrors in the optical path, the synthesizer selection and the associated hardware is all done automatically, allowing an efficient and flexible implementation of observing programs.

After gaining more experience with the standard SIS receivers, it is now possible to do some interventions on the cryostats without losing the receiver alignment. A problem on the mechanical coupling of the mixer backshort of the A100 receiver was solved accessing the broken piece from the cryostat side thereby avoiding the removal of the receiver from its actual position. A second serious failure affected the A230 receiver, the baseline showed a block of spurious lines in one part of the spectrum that limited observations in the wideband mode.

Flexible observation schemes and coordinated bolometer observations are scheduled more and more frequently. Offering the choice between many different receiving systems - standard SIS receivers, bolometers, VLBI, polarimeters and multibeam equipment- is possible only if all the systems are kept fully operational, and if a fast and efficient selection hardware is maintained. All this imposes a high workload on the receiver engineers and the operators.

After further successful testing, the new MPIfR bolometer with 117 channels (MAMBO II) has been routinely used throughout this year. The old 37 channel bolometer is still used as a backup. A new support structure (Fig 3.5) allows an easy installation of any of the bolometer systems.

Fig. 3.5: The MAMBO I and II bolometers at the 30-m telescope

The MPIfR bolometer team also tested a new dilution fridge bolometer called HUMBA. Its sensitivity is close to expectations.

Despite this increased level of activity, the receiver engineers engaged in measurements of infrared filters and vacuum windows for the ALMA project. Furthermore, the tau-meter receiver, the other main activity during the past year, was almost completed; its installation is foreseen for the first part of 2002.

3.4 VLBI

The 2mm VLBI joint experiment between the Metsahovi observatory in Finland and the IRAM 30 meter telescope has produced fringes on two sources. Fig 3.6 shows first fringes found on 3C279. The signal-to-noise ratio was in the order of 10. The experiment has recently been repeated, and the earlier fringe detection was fully confirmed.

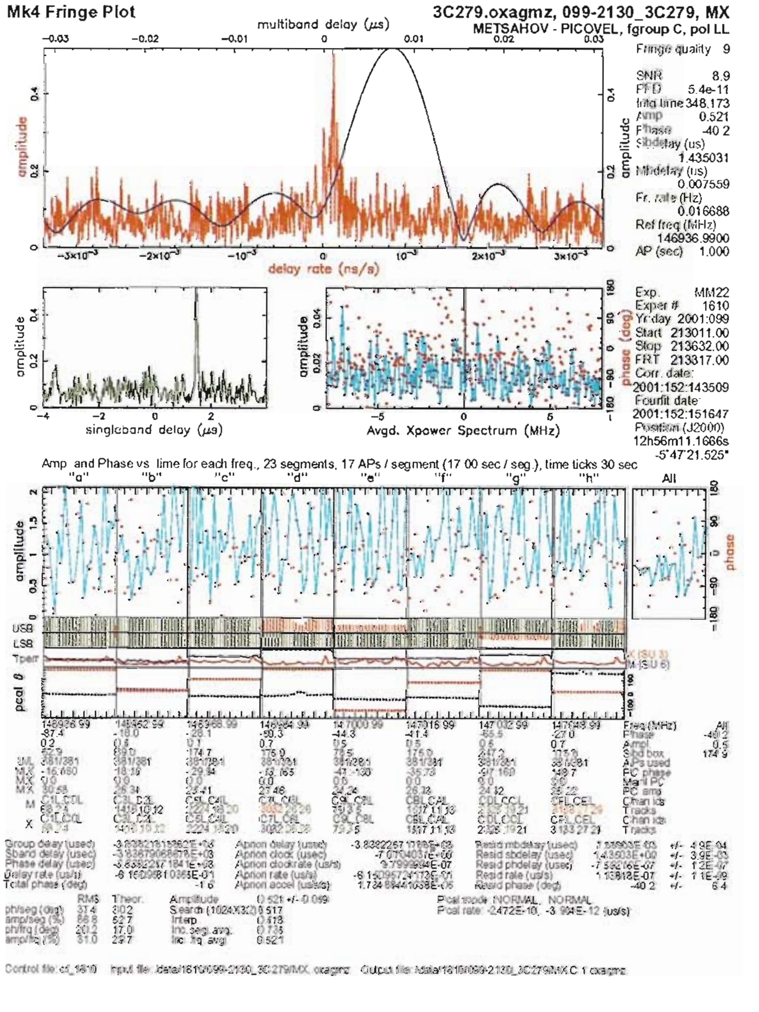


Fig. 3.6: First 2mm VLBI fringes between Pico Veleta and Metsahovi

The VLBI terminal has been improved by increasing the recording rate for digital data from 256 Mbit/sec to 1 Gbit/sec. The formatter has been replaced by the new one from the Mark IV VLBI terminal.

3.5 Backends

The electronics lab used by the former backend group has been moved from Granada to the observatory.

Two 4 MHz resolution filter banks, each with 256 channels, were prepared for use with the multibeam receiver HERA. The refurbished Plateau de Bure correlator VESPA (VErsatile Spectrometer for Arrays) was delivered. VESPA is an autocorrelator with up to 18000 spectrometer channels. It will be used with HERA but also with other spectral line receivers.

3.6 Computers and Software

The installation of the HERA multibeam receiver required mayor modifications of the antenna control software:

(1) tuning software and software for the control of the HERA derotator was developed in Grenoble and had to be integrated into the 30m control system.

(2) The receiver control software was modified to control HERA.

(3) The continuum backend software was modified to read out the nine continuum channels.

(4) Together with the computer group in Grenoble tools were developed to monitor and control the operation of HERA.

During 2001 the software to control the MPIfR ABBA backend was improved: The new 117 channel bolometer is now supported. Automatic transformation of ABBA data from the 30m raw data format to FITS is available now. Observing modes were improved: fast scanning during a subscan is now possible and the limitation in subscan length has been removed.

The current control system is limited by the processing power of the antenna control computer. A concept has been worked out to move data processing (e.g. calibration) to fast Unix workstations. The data of the 4 MHz backend is not transferred to the antenna control computer anymore, but "merged" with antenna tracking information at the end of a subscan under Unix. In 2002, we foresee to shift more online data processing tasks to Unix: e.g., the calibration of on-the-fly maps, and the processing of 4MHz data.

A new data processing computer has been installed. It takes over the functionality of the HP workstations. The new system runs under Linux, offers 200 GB of disk space, in a fault tolerant RAID system that automatically replaces a failing disk by a "hot spare" disk and increases the processing of the current system by a factor of more than two. Also the central computer in Granada was replaced.

The following remote observing stations are operational:
(1) a station at the IRAM office in Granada, now in a separate office, with a video-conference link (2MBit/s radiolink);
(2) a station at IRAM in Grenoble, also with a video-conference link (via an ISDN line). This station will be replaced in 2002 by a new computer;
(3) a station at ENS, Paris. Currently it uses an Internet connection for all communication. This limits the performance. An improvement is expected for 2002;
(4) A remote observing station at MPIfR, Bonn, using an Internet connection and an ISDN line as an alternative. Now two monitors are available.
(5) Another station is under development for installation at the OAN in Madrid. It should be in operation in the spring of 2002.

The communication equipment to link the IRAM network to the University of Granada showed problems and was finally replaced by a new 11 Mbit/s link. The link is based on Linux computers, and a spare system is quickly available in case of failures.

Work on a new control system (NCS) for the telescope progressed in 2001. Whenever possible, software developments for new instruments, like the 4 MHz filterbanks, took into account the specifications for the NCS. The observers' user features and requirements have been largely fixed for a while now, and work on the detailed definition of use cases is in progress from which the user documentation will be produced as well. Requirements and a first design for the observer's user interface are fixed. A first version of the modular design for the system architecture is ready, and we started to define the detailed requirements for the central "coordinator" subsystem that will organize the execution of telescope control and data acquisition during observations. The definition of data formats has begun; requirements for the switching modes and for messages in the NCS have been worked out. Tools for a proper software documentation have been selected and prepared. Prototypes of new online processing tasks are already working in the current control system. The new tasks run on fast Unix systems and will be able to handle the much higher data volumes that are produced by the new autocorrelator and the new 4 MHz backends. It is planned to have online data processing of on-the-fly maps and the 4 MHz backends available in 2002.

3.7 Infrastructure

Four new varistors have been installed in the three phases plus the neutral line of the UPS (No-Break supply). Previously, a similar installation was made with the external electricity supply. The aim is to suppress or minimize problems in case of overvoltage due to electrical coupling during lightning. The batteries of the UPS have been replaced. The old ones have been working without problems during 10 years. The observatory's high voltages station has been revised in order to comply with current electrical regulations. Minor improvements had to be implemented.

Damaged eternit plates on the antenna pedestal have been replaced by new ones. These plates were damaged by severe storms during the previous winter period.

Fig. 3.7: Replacement of broken eternit plates at the 30-m telescope

A sensor of rain/snow has been installed to help the telescope operator. The meteo station has been equipped with new sensors for relative humidity and temperature. The new humidity sensor has a precision better than 2% over its entire range. This has made the refraction correction for pointing more reliable.

The Q-line of the maser has been measured at the observatory. After ten years of maser operation the value obtained (1.84E+09) is still good enough to guarantee a good operation without the necessity to recoat the cavity.

Very strong rainfall at the end of September 2001 severely damaged the road between Borreguiles and the telescope. The company managing the ski station, Cetursa, made preliminary repairs before the winter season started.

3.8. Safety

The access door to the telescope tower has been modified to be opened towards the inside in order to avoid snow blocking the opening of the door to the outside.

All the machinery in the workshop and cranes in the antenna tower have been revised and modified to comply with the current safety regulations.

The central for fire detection is now fully equipped with new fire sensors. The year before, only 37 of the total 83 sensors were installed. During the year 2001 the other 46 have been installed. The new kind of sensor is more reliable, sensitive and auto identified in the case of a fire.

As in previous years, a First Aid training course was given at the observatory during two days. The goal is to get the staff familiar with the medical equipment at the observatory in order to have an efficient response in case of human emergencies.

In order to guarantee an emergency evacuation at any time, IRAM is collaborating with the ski station and from there to Granada.

Antiallergic bedlinens have been purchased for the rooms at the telescope.

3.9 Summer School on "mm-Observing: Techniques and Applications"

The computer group installed twelve computer systems in Pradollano for the IRAM summer school. The systems were connected to a local network that was linked with the IRAM network via a modem line. The standard data processing software was available from a local file server.

Fig. 3.8: Participants of the EuroLabCourse 2001 performing observations at the IRAM 30-m telescope

4. PLATEAU DE BURE OBSERVATORY

4.1 Staff Changes

In February, Yvan Mourier joined the group of telescope operators. In December, Bruno Convers was recruited as a member of the technical group at the Observatory.

4.2 Construction of Antenna 6

In the spring of 2001 it was decided to restart the construction work on Antenna 6 which had begun in 1999, before the accidents. The antenna mount had to a large degree been completed, but most of the components of the reflector had still to be brought up to the Plateau. The most problematic item was the reflector central hub. Its weight of about 5 tons excluded a transport by helicopter. The surface panels were a second major item. The set of aluminium panels fabricated for the 6th antenna had already been used to replace the original carbon fibre (CF) panels of Antenna 3, whose protective and reflective Hostaflon layer had deteriorated.

Mandatory load tests, performed in June 2001 on the modified cable-car system which will in the future exclusively be used for the transport of materials, offered the opportunity to bring the central hub up to the Plateau. All other components, e.g. the bars and nodes for the back-structure as well as the panels, were brought up by helicopter. The assembly of the reflector could then start. The work was subcontracted to the company Cegelec/ALSTOM. This external team was reinforced by IRAM staff. Also, P. Raffin, an engineer who worked at IRAM during the early design and construction phase of the Plateau de Bure antennas, was asked to closely monitor the work. The main difference in the assembly procedure, with respect to that used in the other antennas was the use of a precision theodolite with laser plummet, capable of measuring simultaneously with high accuracy the position and distance of a target (back structure nodes or panel edges). The assembly of the back structure took 8 weeks and ended on August 31st.

Meanwhile, the Hostaflon foils were stripped off the old CF panels of Antenna 3. Tests which had been performed several years ago had shown that the accurate, but non-conductive surface of the panels could be made reflective with a thin layer of a silver emulsion paint. A product with an acrylic base was chosen because it proved to stick to the epoxy surface in the harsh Plateau de Bure conditions for many years. New tests were made on how the silver could best be protected with minimal losses for mm-wavelength radiation. Several protective paints of different layer thickness were applied on silver-covered panels; the adherence of the paint and the panel reflectivity were measured in the laboratory. Accelerated environmental aging tests in the presence of UV radiation were also performed on witness samples at the Centre National de Photoprotection. We settled for a 40-micron film of white two-component polyurethane acrylic paint, which offered the best compromise between minimal losses throughout the mm-bands, predicted longevity and removability. The white titanium dioxide paint was applied in three thin layers in a professional workshop atop a 15 micron-thick film of silver paint. The paint thickness and the reflectivity were checked for a subset of panels before shipping them to Plateau de Bure. The measured losses were found in all cases to be below 3% at 230 GHz (2% at 115 GHz).

Fig. 4.1: The back structure of Antenna 6, as of August 31st, 2001. Surface panels were placed in September and October, and also the thermal insulation of the yoke.

The painted panels, plus 15 brand new Hostaflon-covered panels we purchased from MAN, were brought up to the Observatory by helicopter and fixed on the back structure with the help of motor-driven spindles. They were then pre-adjusted in position and the reflector back structure closed with METAWELL panels. This phase took 6 weeks and the reflector was completed by mid-October

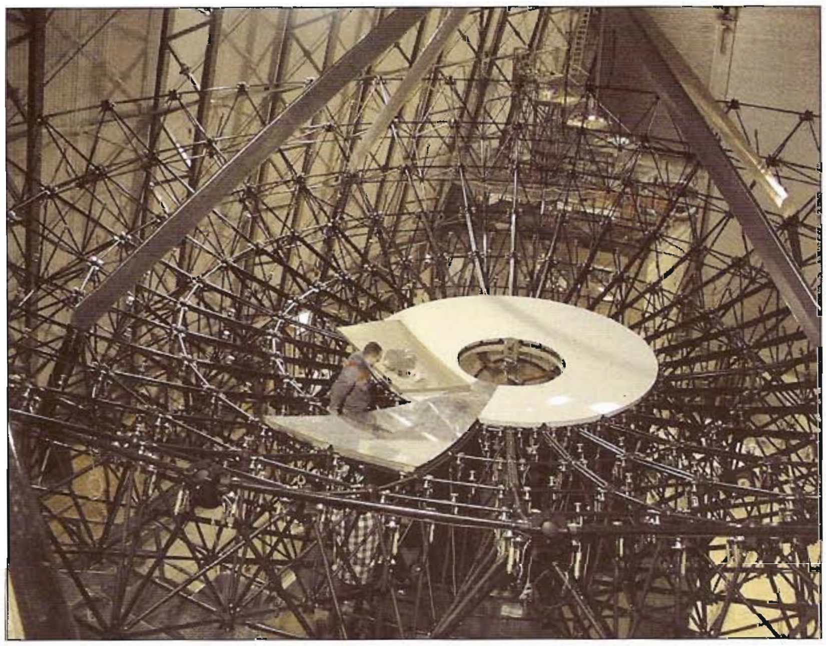


Fig. 4.2: Top-down view on Antenna 6. The first ring (16 panels) is already completed. At the vertex, the theodolite with laser plummet for high precision panel positioning can be seen.

Fig. 4.3: The surface of Antenna 6 after three weeks of panel assembly work. Surface fine adjustments will have to await holography measurements on astronomical masers.

Fig. 4.4: Antenna 6 shortly before completion, end of November 2001.

The work that remained to be done included the finishing of the thermal insulation of the mount, the painting of the transporter and receiver cabin, the electrical cabling, the installation of the receiver and of the antenna and receiver control hard- and software, and the testing. Altogether, these tasks took 8 more weeks to complete, and the antenna was moved to the northern track on December 11th. After a few days of debugging, Jupiter was detected in the single dish mode and, on December 16th at 21h35 UT, the first fringes were observed on all baselines connected to Antenna 6.

4.3 Observations

The five-element interferometer was operated with high efficiency in 2001 with almost no downtime due to equipment failure during scheduled observations. The receivers all performed well throughout the year without significant problems. The weather conditions on the site were poor in January, but the conditions were relatively good from spring to fall, and excellent in December.

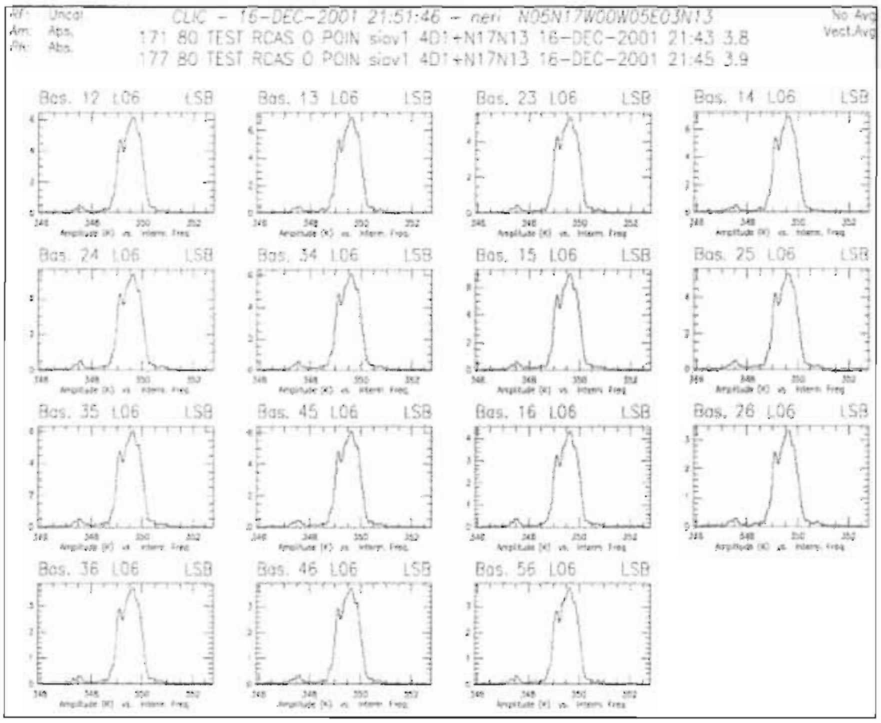


Figure 4.5: First fringes resulting from observations with Antenna 6. These were made at a frequency of 86.243 GHz on the SiO (v=1, J=2-1) masers in the circumstellar envelope of R Cas

The scientific throughput of the interferometer was one of the highest ever achieved: about 100 different observing projects were scheduled at the Observatory in 2001, including a large number of extragalactic projects. In Annex 7.2 the proposals which received observing time in the course of 2001 are listed. All except 6 proposals have successfully been completed.

As we still try to strictly limit the total number of people working at the Observatory at any moment in time, the number of configuration changes remained limited. Only projects using the C and D configurations were scheduled in 2001. Without an extended configuration being offered, the most interesting scientific results of the interferometer came from observations of the carbon-monoxide line-emission in high-redshift galaxies in the D configuration between spring and fall.

For the same reason, i.e. in order to keep the number of people at the Observatory as small as possible, regular scientific observations were carried out with an astronomer on duty providing remote support from Grenoble in the period from June to November.

However, with the arrival of Antenna 6 in December 2001, a new performance level of the interferometer was reached. In the weeks that followed "First Light" on December 16th , substantial efforts were made to stabilize the tracking of Antenna 6 in the presence of wind, and to adjust the surface to an accuracy of a few tens of microns. Monitoring is underway to evaluate the long-term performance of the antenna.

4.4 Maintenance

In order to better prepare and coordinate all activities at the Observatory, including the work on Antenna 6 and the necessary maintenance during summer time, a "Cellule Bure" was created at the Grenoble headquarters. It coordinated all activities related to the construction of Antenna 6, organized the training and working schedule of personnel recruited on fixed-term contracts, scheduled transports by helicopter or transports on ground, and provided assistance to the Observatory staff when needed. The group also helped to establish technical procedures that have resulted in a more efficient maintenance, and to purchase new engines, critical spare parts and materials to support antennas and instruments. Despite these efforts and the fact that the construction of Antenna 6 occurred mostly in parallel with the maintenance work, the time used for the antenna maintenance had to be spread over a somewhat longer than usual period in order to allow the execution of special tasks like the installation of the 22 GHz receivers on antenna 2 and 5, and various tests with the upgraded Phaser.

Fig. 4.5: Four of the six antennas of the Plateau de Bure array. A mobile telescopic fork-lift (left foreground) and an articulated platform for aerial repair work (centre) were purchased for outdoor activities at the Observatory.

4.5 Data archive

A considerable effort was made to create a homogeneous archive of data from the Plateau de Bure Interferometer. The entire archive was stored on CD-ROMs, and at the same time a copy was created for safety. To minimize the risk of duplicating any source of error, a copy was made in parallel on a different physical support (DAT). Archiving work was started in September and completed by the end of 2001. Work to provide a Web-based access to the entire Plateau de Bure Archive was started in December in collaboration with the Centre de Données Stellaires in Strasbourg (CDS).

4.6 Major activities to further improve the Plateau de Bure Interferometer

Array configurations

Early in the year, efforts were made to design a new set of configurations for the six-element interferometer. Several hundred thousand antenna configurations were investigated and the resulting uv-plane coverage analysed for high-brightness sensitivity, angular resolution and minimum antenna moves. These requirements have led to the selection of three new array configurations for the winter period 2001/2002. This set of configurations is not definitive and will be revised when the new stations on the northern track extension will become available.

Calibration

Work was made to improve the calibration pipeline at the Observatory. An experimental Web-based facility was developed to allow selected users of the interferometer to directly access calibrated data headers, calibration summaries and uv-tables of their own projects. Users' feedback is awaited. At the same time work is already underway to improve the performance of the system, and in particular to establish a totally automatic data calibration pipeline with automatic quality assessment.

Phaser upgraded

The Phaser underwent a major upgrade in October 2001. The new phasing system integrates twelve phasemeters, one for every receiver, and provides the appropriate Walsh modulated phase reference to which the receivers are locked. The system was tested thoroughly and was found to provide excellent performance since then. The new system ensures six-antenna operations and provides additional phase accuracy, a necessary condition for future VLBI observations with the six-element interferometer. Regular astronomical activities were temporarily suspended during this work.

Improved computer resources

The need to accelerate the data reduction, data storage requirements, and concerns about the reliability of the antenna control computer made the installation of new computers a top priority. Several Linux-system based computers dedicated to the data calibration pipeline and data reduction, to the monitoring of real-time antenna information and for offline backup purposes, were purchased and thoroughly tested during the summer. The new computers were installed early in September and were found to provide a uniform and reliable interface to the antenna control. The data acquisition, reduction and archiving pipelines were moved to Linux. In addition, to increase operational reliability, a duplicate of the antenna control computer was installed for almost instantaneous replacement in case of failure. These tasks were carried out without noticeable downtime for astronomical observations and have significantly improved and streamlined the operation of the interferometer.

A new 22GHz radiometric phase-correction system

The development of a new phase-correction system to correct for wavefront distortions caused by moving cells of atmospheric water vapour was progressing well. The system uses a room-temperature three-channel radiometer on each antenna to detect emission from water vapour while rejecting spurious emission from cloudlets and water droplets. During summer, two prototype 22GHz radiometers with an off-axis optical alignment were installed on antenna 2 and 5. Antennas 1, 3, 4 and 6 will be equipped in 2002. First investigations have shown that the long-term stability of the cabin temperature has to be improved to allow a reliable phase correction. Modifications in the temperature insulation of the cabins are envisaged for the summer of 2002.

Infrastructure improvements and other site activities

Efforts to improve the observatory infrastructure continued this year. For the first time, and after more than 15 years of extreme weather conditions at an altitude of 2550 m, the cladding of the hangar and of the tunnel leading from the upper cable car station to the main building were inspected. Work was contracted to TECK : the cladding inspected for sealing defects and screws tightening. The hangar door, which started showing its age, was completely overhauled by KAUFFMANN KG, and modified to comply with present safety regulations. As another safety measure, anti-fall protection nets were installed to protect people working on the scaffoldings. Various other maintenance tasks were carried out on the buildings by the Observatory staff, and an accumulation of unused material was removed from the hangar in view of the construction work on Antenna 6.

Efforts continued to improve the audio-visual link between the observatory and the Grenoble headquarters. The system was regularly used for group meetings. Also, a direct link to the hospital in Gap has been installed for medical assistance when needed.

5. GRENOBLE HEADQUARTERS

5.1 SIS GROUP ACTIVITIES

The SIS group has continued work on the production and development of superconducting mixer devices for the IRAM observatories. At the same time developments for ongoing projects like HERSCHEL, SOFIA and for future projects like ALMA have been pursued.

SIS Junctions for the standard 100 and 230 GHz SIS mixers have been produced and the production and process refinement for the new design 350 GHz mixers was carried on (see related results from the receiver group).

The development of SIS junctions for HIFI channel 1 (480-640 GHz) continued in collaboration with LERMA (former DEMIRM). A second-generation RF design using two junctions in parallel was implemented and first batches were successfully produced without major loss in yield.

A set-up for radiation hardness tests has been developed to qualify the produced junctions for space applications. Tests have been made using 10MeV protons at the Cyclotron source of CERI, Orleans.

Fig. 5.1: The CERI 10MeV Proton beam line as used for radiation hardness tests for SIS junctions. The cylindrical piece in the foreground is the sample vacuum chamber containing a Rutherford disperser, the sample stage and the semiconductor reference counter.

The results show that the produced junctions can survive extreme radiation levels but some slight modifications in the I-V-characteristics may occur.

The promising technique of NbN Hot-Electron-Bolometric mixers on MgO buffer layers has been used for HEB devices produced for the MPIfR in Bonn, and for a consortium including the Rutherford Appleton Laboratory and the University of Kent.

The recent IRAM development of cryogenic RF MEMS (Radio Frequency Micro Electro Mechanical Systems) has been continued and very encouraging results were obtained. First prototypes of electrostatic tuneable air bridges from Nb have been fabricated and the corresponding process stabilized (see **Fig. 5.2**). The developed process is compatible with the SIS junction fabrication process and will eventually allow completely new types of tuneable cryogenic millimetre wave circuits.

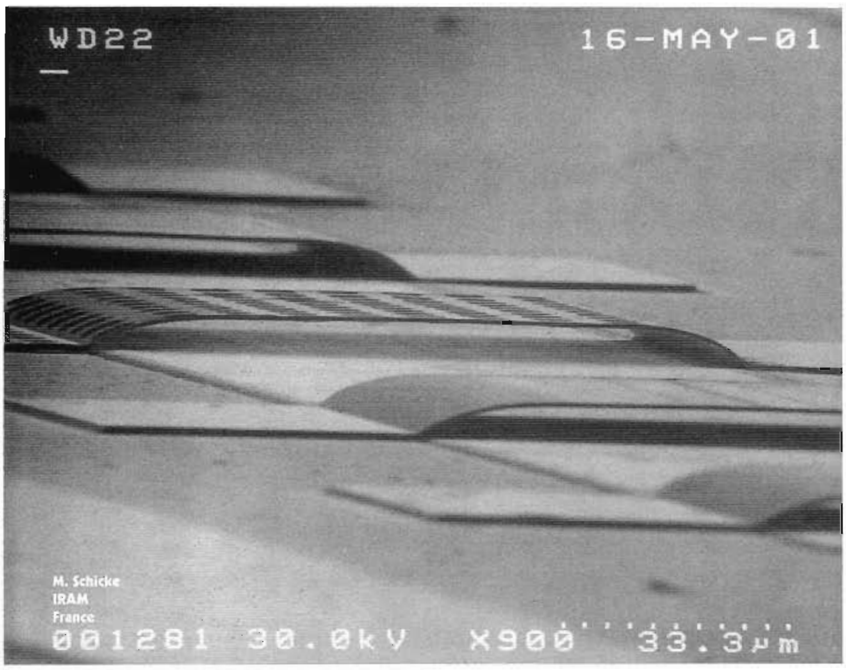


Fig 5.2: Prototype surface mounted tuneable micro capacitors in Nb air bridge technology. The height of the air bridges is 5µm and the bridge length 100µm. The corresponding process is fully compatible with SIS junction fabrication processes.

Exploration of new equipment and materials continued. Equipment for improved plasma etching from various suppliers has been thoroughly tested and the related processes underwent a first optimisation.

Several new types of high precision profilometers have been tested and the optimum instrument was identified and will replace the very old and unreliable equipment.

First samples of high quality AlN films using reactive sputtering were prepared and characterized. AlN will have a broad impact on future SIS technology ranging from reduced size capacitors and striplines over etch stop layers up to high current density tunnelling barriers.

5.2 RECEIVER GROUP ACTIVITIES

5.2.1 Receiver construction and maintenance

230GHz Multibeam receiver (HERA)

HERA, the new IRAM 230 GHz **HE**terodyne **R**eceiver **A**rray is a special project whose construction was supported by the receiver group. The first 9 channels of the HERA receiver were characterized in the laboratory for a number of frequencies of astronomical interest. The receiver group realized the physical installation and initial RF testing of HERA in the 30m telescope receiver cabin.

HERA has successfully been installed within 1 week at the 30m telescope in May 2001. The current configuration contains total functionality for 1 polarization (9 beams 3x3 , RF 210 to 276 GHz, IF 1 GHz). The noise temperatures of the single pixels are between 110 K Tssb from 210 to 235 GHz, with increasing values up to 350 K towards 270 GHz. The performance of the individual pixels is hence comparable with that of existing single channel receivers at the 30m telescope.

HERA has been commissioned in 3 successive commissioning runs. The instrument has been thoroughly characterized in its optical and electrical qualities and different observing modes such as position and frequency switched raster and on the fly mapping have been successfully tested. No major difficulties were encountered and the measured characteristics of the instrument were very satisfactory. HERA was therefore offered to the IRAM user community for the winter period 2001/2002.

In connection with VESPA, the new autocorrelator backend, HERA greatly improves the mapping speed and data quality for extended molecular line observations while offering simple and user-friendly operation.

Fig. 5.3: HERA at the 30m telescope during the final phase of installation and cabling in May 2001. The whole system is self contained including cryogenics, RF and control electronics in order to minimize space requirements in the 30m cabin. To the right of the stainless steel cryostat the the K-mirror of the derotator unit is visible (black).

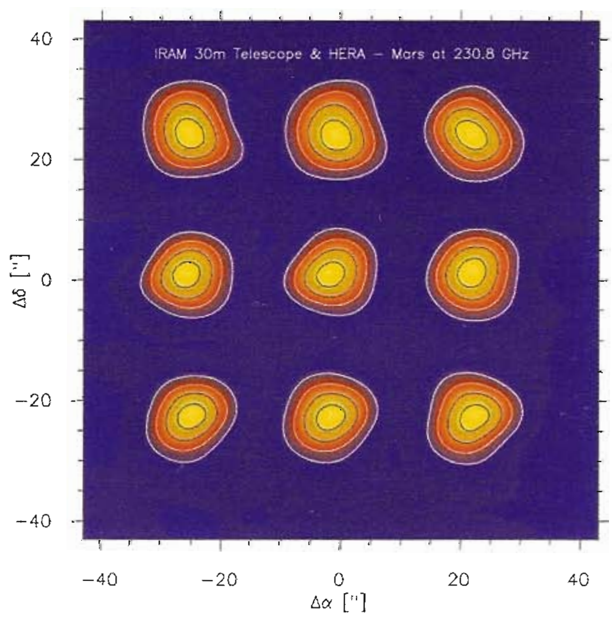


FIG. 5.4: Beam map of HERA on Mars in continuum mode at 230 GHz. The map was obtained with OTF mapping in right ascension while tracking the field rotation.

Current work on upgrades includes a SSB calibration system, the completion of the tuning list, a set of 1GHz wide filterbanks and finally the 2nd polarization 3x3 module. The second polarization module can be used to: further enhance sensitivity, increase frequency coverage (due to independent LO), perform polarization measurements or allow for optimized sensitivity observing schemes for point sources.

Plateau de Bure Interferometer

The receiver group ensured the monitoring and minor repairs of the receivers in operation. The dual channel 100/230GHz receiver for Antenna 6 was installed on the site and put into operation for regular observations. The first two 22GHz water vapor radiometers were installed in antennas 2 and 5. Initial tests show that the intrinsic total power stability is as good as in laboratory tests under stable thermal conditions; the small spacing between antennas 2 and 5 at the end of 2001 did, however, not allow significant tests of atmospheric phase corrections to be made.

New receivers for Plateau de Bure.

These receivers will have four frequency bands (nominally 100, 150, 230, and 300GHz), each one being dual polarization. A preliminary design of the cryostat, the optics and for the four RF modules has been made, such that either the cryocooler or any of the four RF modules can be easily dismounted for servicing (see **Figs 5.5 and 5.6**). The cryogenics will be based on a GM/JT Daikin CG308 cryocooler. The optics for each band comprises two refocusing mirrors, polarization splitting by a grid, and two corrugated horns.

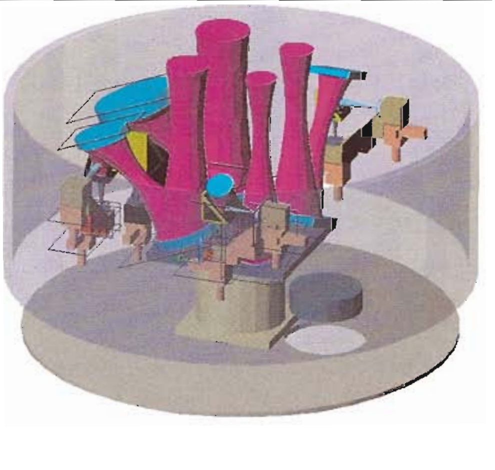


Fig. 5.5 : A view of the optics design for the new PdBI receivers, showing the beams for the four frequency bands, the mirrors, the LO injection couplers, and the mixers.

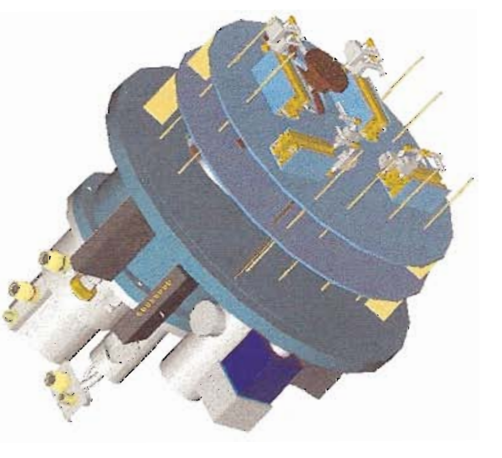


Fig. 5.6 : An exploded view of the design for the new PdBI cryostat, showing the 300K, 70K, and 15K plates, with radiation shields removed.

A new type of SSB SIS mixer has been designed and tested for the 260-360 GHz band. It has a receiver noise of 80K over the design band, with an image band rejection in the order of 14dB.

A wiring plan has been defined, including the thermal budget, the choice of connectors, and a simplified design for thermal shunting. Flexible thermal straps made of multi-layer OFHC have been characterized.

New control modules interfaced to an I2C bus have been tested (junction bias, HEMT bias, vacuum monitoring) or are under development (temperature measurement, Schottky diode bias).

Seven LO boxes for the 150GHz band have been built, except for the Gunn oscillators for which we are awaiting delivery.

22 GHz radiometers for Plateau de Bure

The purpose of these radiometers is to measure in real time the brightness of the 22 GHz water line close to the line of sight to the astronomical source. From that measurement, one derives a correction for the fluctuating water vapor contribution to the path length and signal phase. Actually, three channels, each 1 GHz wide, are used, one centered on the water line, and one on either side; this allows, in principle, to measure independently not only the water vapor emission, but also the liquid water (cloud) emission, and to eliminate the spillover contribution. This correction scheme is expected to provide the largest improvements on long baselines and under summer observing conditions.

Two receivers have been completed, extensively tested in Grenoble, and installed on PdB antennas 2 and 5 in the autumn. Until the end of 2001 it had unfortunately not been possible to perform a full astronomical test, due to the combination of the good atmospheric conditions during typical winter observing conditions, and the close spacing of antennas 2 and 5.

A third receiver has been completed in 2001, and orders have been placed for the components of four other receivers, for a total of 6+spare.

Fig. 5.7 : The first 22 GHz water vapor radiometer installed on site. This receiver is located to the side of the SIS receiver. The corrugated horn is coupled to the telescope via a pair of mirrors (elliptical, flat), partly visible on the left of the picture.

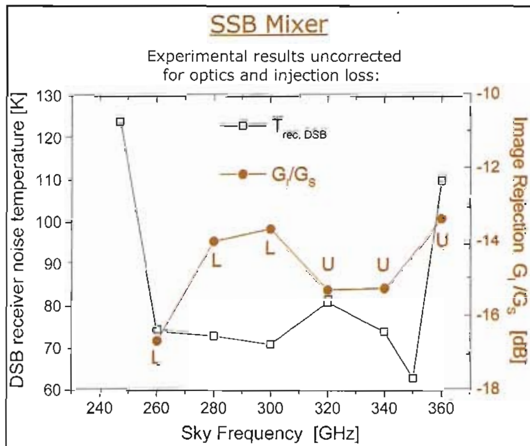


Fig. 5.8 : Performance of the new SSB mixer developed for the PdB interferometer. The noise is less than 80K SSB over the design band, and the image rejection better than 13dB.

5.2.5 ALMA Activities

Optics

The ALMA front end optics, a work package under IRAM responsibility, involving a number of other institutes, and requiring close coordination with the cryogenics work package, has reached in 2001 a near-final state. The baseline optical configuration for each cartridge, the sizes and the layout the cartridges in the cryostat have been defined.

A collaboration with the Arcetri Observatory has been initiated to design, build, and test a prototype for the so-called common optics, i.e. the part of the optics that lies outside the cryostat (bands 1–4). Work has also started on the design of a focal plane calibration system.

In collaboration with colleagues from SRON, the IRAM antenna range has been used to characterize the beam pattern (amplitude and phase) of a prototype receiver for ALMA

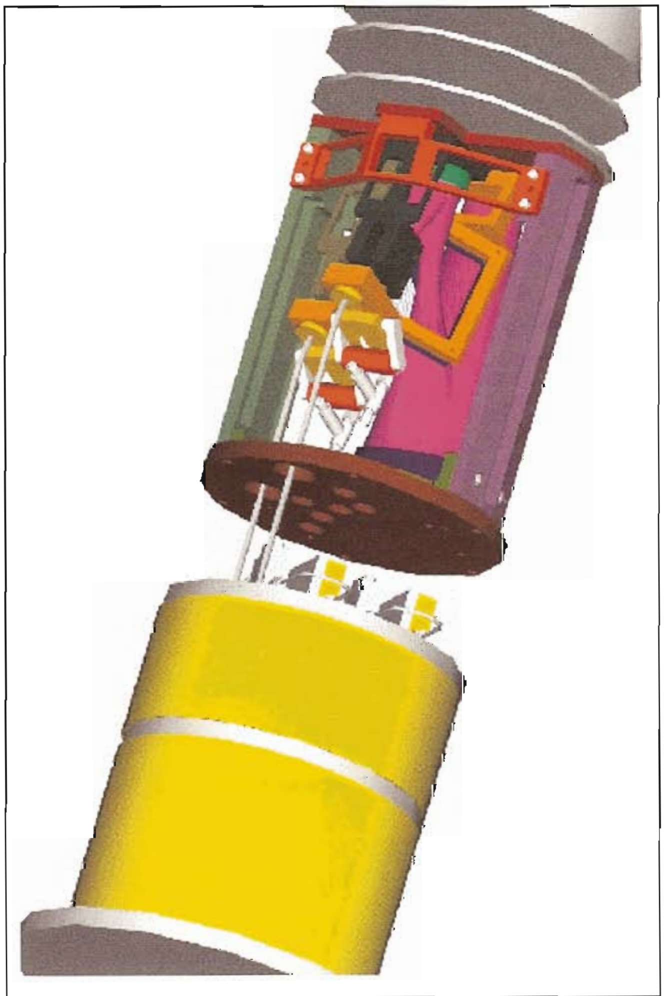
Band 9 (600-720 GHz). This demonstrates the capability to perform detailed optics testing in any of the four first-generation ALMA bands (3, 6, 7, and 9).

Band 7 cartridge

A detailed optical and mechanical design has been completed for the Band 7 cartridge (see **Fig. 5.9**). The adopted design is flexible and provides space for the accommodation of mixer designs that are currently under development beyond the baseline version. What remains to be done is a cryo-mechanical analysis of tolerances, and an optimization of mass versus thermal and gravity deformations.

Band 7 mixers

A double sideband SIS mixer for ALMA band 7 (275-370 GHz) has been designed and characterized. It meets the ALMA noise specifications (133K SSB, 66K DSB, over 80% of the RF band), however, its IF bandwidth is only 4GHz (8GHz specified for a DSB mixer). This is our baseline design proposed for ALMA. Two alternative routes are pursued beyond the baseline design.



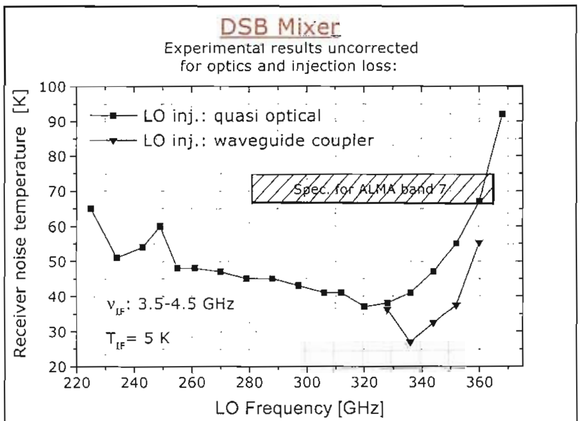


Fig. 5.10 : Performance of the baseline DSB mixer developed for ALMA Band 7.

Fig. 5.9 : The Band 7 cartridge. The basestructure comprises four temperature stages linked by fiberglass tubes (one removed). The optics and RF assembly is mounted on top of the 4K stage; it comprises three refocusing mirrors, a polarization diplexing grid, LO injection couplers, and mixers.

A new mixer with lower output capacitance, that should allow to meet the IF bandwidth specification, is being designed.

The development of sideband separating mixers, based on quadrature couplers, is also pursued. A prototype coupler has been designed and successfully tested.

Windows and infrared filters
This task, under the responsibility of IRAM Spain, is supported in Grenoble as far as the windows are concerned.

5.3 BACKEND DEVELOPMENTS

5.3.1 VLBI equipment for the PdB interferometer

The MKIV terminal, consisting of a tape unit, formatter, decoder and a control computer, has been assembled and is ready for testing in the Grenoble laboratory. A new GPS receiver, featuring a maser-monitoring capability has been purchased and modified to serve as the observatory master clock. On the PdB, the 8 correlator units have been fitted with the adding modules for phased array operation. The GPS antenna has been installed.

5.3.2 Narrowband Spectrometer for all Pico Veleta receivers

The 5-antenna correlator which had been removed from the PdB has been dismantled and re-assembled under the form of a **VE**rsatile **SP**ectrometer **A**rray (VESPA) that can be used either with the single channel receivers or with the new 9-beam 1.3 mm receiver. Its installation on the site was completed on September 11, 2001. It allows for variable resolution spectrometry with a maximum of 18.432 channels. The widest possible bandwidth is 640 MHz for 9 receivers, 320 MHz for the future 18-beam receiver, or 160 MHz for 36 receivers.

5.3.3 New PHASER and Lo-Q Racks for the Plateau de Bure

To perform the functions of fringe tracking, phase switching and cable monitoring for 6 antennas, a simple upgrade of the already aged existing equipment was not practical, so it has been entirely re-built using new technology.

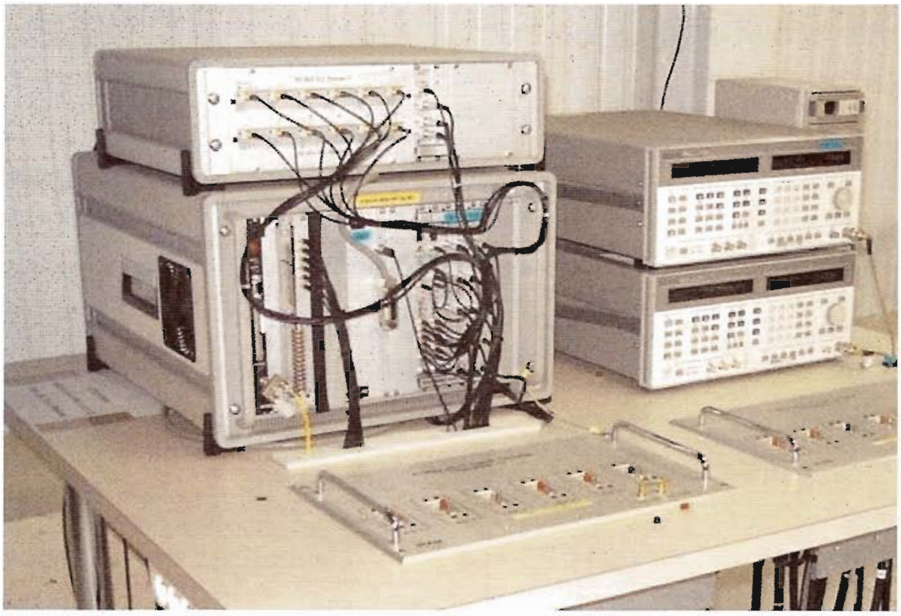


Fig. 5.11: The new phaser for the 6-antenna Plateau de Bure Interferometer

The frequency synthesis plan has been revisited so that decimal frequencies can be generated, to be compatible with VLBI observations. The phase noise of the phasemeter clock has been reduced, and now allows for length variations as low as 1.8 micrometers to be detected on the approximately 400m long coaxial cable that links the antennas with the central building. This yields a significant improvement of the overall phase error budget of the interferometer

5.3.4 Wideband correlator for multi-beam receivers

A prototype 1-GHz, 512-channel autocorrelator has been built and tested in the laboratory. It includes all the modules that have been specially developed. Of particular interest are:

- A SSB mixer, operating at 1.3 GHz, with 2x450 MHz output and a rejection of the unwanted sideband better than 25 dB,
- A full 2-bit sampler,and associated elements, working at 1 Gs/s
- A times-8 demultiplexer, using two commercial single-bit devices and a special disciplining technique.

For those modules which have already reached their specified performance, the series production has started. The final design foresees 18 spectrometers of 1GHz bandwidth, at a fixed resolution of 2 MHz per channel.

5.3.5 ALMA

The Fast Demultiplexer Unit of the sampler test bench has been built and successfully tested. It has allowed to experiment with a disciplining technique that happens to be of interest for ALMA.

The task of designing and producing the phase-controlled 4 GHz sampling clock has been assigned to the Grenoble group.

More information and images are available on www.iram.fr/TA/backend

5.4 COMPUTER GROUP

5.4.1 Hardware Changes in Grenoble and on the Plateau de Bure

The capacity of the NAS file server has been doubled to the level of 1TeraBytes and its reliability has been improved by adding a library of high capacity cassettes for backups. Now all users have their own data on this server accessible either from Windows or from Unix/Linux.

Astronomical projects using our fastest HP processor for data analysis have all been moved to the file server. For the other projects, it has been found better to stay in the former configuration with one RAID system attached to the computing server.

At Bure the part of the computer system that is not involved in real-time processing has migrated to redundant Linux servers and stations connected to a twisted pair fast Ethernet network. The real time system based on HP computers and VME microprocessors remained unchanged except that now the HP machines are redundant and are connected to a Raid disk system.

At Grenoble more and more astronomers use PCs under Linux. An automatic configuration procedure has been set up to simplify and standardize the setups.

5.4.2 Software Developments Related to New Instruments

A number of new instruments have been installed at Pico Veleta and on Plateau de Bure for which software has been developed and implemented by the Computer Group:

At the 30m-telescope the following activities have been carried out:
- The new multi-beam receiver (HERA) control software running on a VME processor under Linux has been tested on the site (PV) and then integrated with success into the current observation system.
- For the new control system, that is being developed since several years, the axis control loops have been written. They are executed in a VME system including new hardware/encoder interfaces and running Linux.

On the Plateau de Bure the following tasks have been accomplished:
- The control and acquisition software of the two 22 GHz radiometers has been implemented. It is running in the current receiver VME system under OS9.
- The antenna control and monitoring system has been expanded to support the 6th antenna.
- The acquisition software for the new correlator has been successfully installed. It is one more new instrument controlled by VME processors under Linux with real time requirements.

5.4.3 ALMA Related Activities

In parallel to the tasks mentioned above, progress has been made on the ALMA prototype antenna mount control software developed and tested under Linux. This development is based on new software technologies like networked objects and a portable operating system adaptation layer which give the possibility to develop/debug under one OS but to run the final product under another one.

In order to prepare for future developments we are gaining experience with LABVIEW and the CAN bus, a tool and a bus widely adopted for ALMA.

5.5 TECHNICAL GROUP

5.5.1 Mechanical Workshop

The technicians of the mechanical workshop have realized the construction of a great number of instruments such as couplers, mixers and horns for the ALMA related receiver development, and for the new generation Plateau de Bure receivers. In addition, microwave components for the second polarisation of the multiple-beam receiver for the 30m-telescope have been built. The technical staff has been trained to use SURFCAME 2000. The mechanical workshop has been equipped with a new 4 axes lathe to produce mandrils for the production of horns and other components by electro-forming.

Fig. 5. 12: Development of a coupler for the ALMA band 7

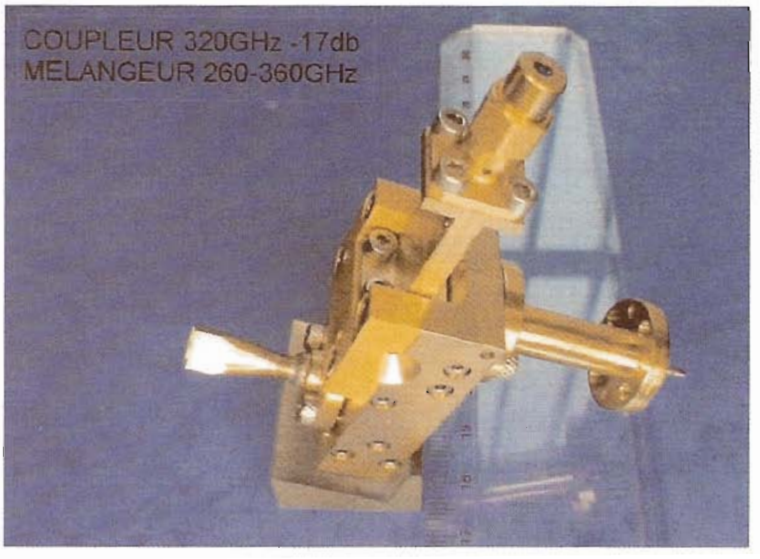


Fig. 5.13: Assembled coupler and mixer block for the ALMA band 7

5.5.2 Drawing Office

In collaboration with the microwave engineers the group participated in working out the details for all the studies and in the mechanical follow-up of the project before the actual construction in-house or carried out by external companies (multi-beams, 22 Ghz, ALMA, Bure). Following the Mechanical Desktop training, all our studies can be presented in 3D.

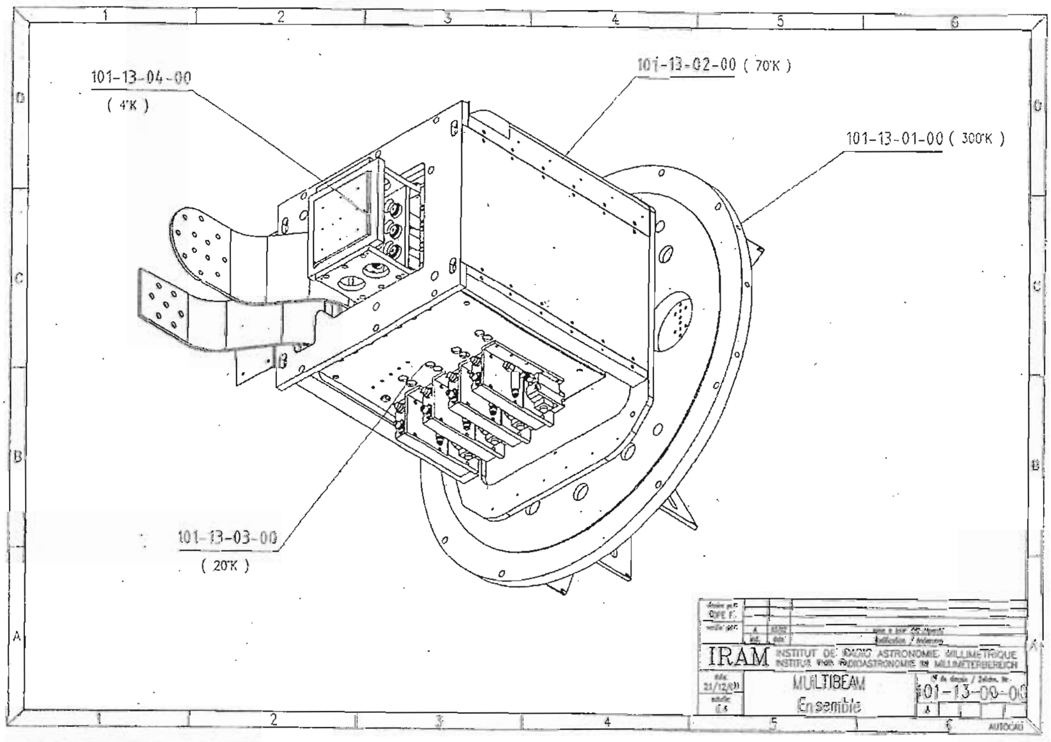


Fig. 5.14: Example of a drawing produced during the development phase of the IRAM multibeam receiver now installed at the 30m-telescope.

5.5.3 Electro-forming

The installation for electro-forming has been running almost 24 h per day over the whole year for the production of the horns for the projects followed through by the division.

5.5.4 Extension of the mechanical workshop

The construction work started mid-November 2001 and should be completed by April 2002. It will add 170 m2 of new surface which will allow a more adequate installation of the different high precision machines, and also provides additional office space to prepare the work on the CNC machines.

5.5.5 Plateau de Bure Antenna N° 6

The mechanical group has taken an active part in the assembly of the reflector and the implementation of antenna 6. The antenna A6 left the assembly hall on December 17, 2001.

5.5.6 Bure Observatory

In collaboration with the team at Bure the group has prepared the maintenance schedules for the interferometer (works during summer, provisional works and replacements)

5.5.7 Blondin

The mechanical group has represented IRAM during the different discussions with the contracting architect concerning the conformity of the machine to standards and specified its transportation needs (plateaus, water and fuel tanks, ...)

Fig. 5.15: The picture shows a newly constructed container for the transport of liquids during a test with the rebuilt cable car.

6. PERSONNEL AND FINANCES

6.1 Personnel

The personnel plan for the year 2001 allowed for 103.3 positionsat the end of the year, only 100.5 positions were filled with staff on longer-term or unlimited contracts. The remaining positions were in the process of reallocation. In addition, almost 10 positions were used for shorter-term contracts (see below). Of the staff positions 74 are based in France and 26.5 in Spain. The MPIfR (Bonn) and the MPI für Extraterrestrische Physik (Garching) jointly financed half a position in the SIS laboratory for the production of diodes.

Furthermore, 4 post-docs (3 FR, 1 ES), 3 thesis students (3 FR) and 4 « coopérants » (ES), plus 1 person delegated by DEMIRM/Paris in the framework of the FIRST project, worked at IRAM.

Extra workloads during certain periods of the year made it necessary to issue a large number of limited-term contracts. This corresponded to:

- 5.71 man-years on Bure, to complete the 3 teams for maintenance and logistic support,
- 4.14 man-years in Grenoble, for replacements and additional work in the Administration and in the technical groups.

6.2 Finance

IRAM's financial situation in 2001, as well as the budget provisions for 2002, are summarised in the attached tables.

2001 - Operating budget

a) Expenditures were lower than anticipated .

- Savings were made in the personnel budget, since not all positions were occupied. This was off-set, however, to a large extent by increases in other parts of the operation budget. More work than ever before was subcontracted to manpower companies. This offers greater flexibility to respond to temporary needs when they arise. Included in this is the cost for a medical aid who was present on the Plateau throughout most of the year.
- It had been expected that the cable car system would become available again for the transport of materials. The amount foreseen for its operation by a subcontractor was not spent because the system was not ready. This delay affected other tasks that had been planned for the

summer of 2001 and which were slowed down or postponed in order to avoid additional helicopter flights.

b) Income was much higher than expected, due to

- higher banking interest rates
- reimbursement of services rendered by IRAM personnel
- financial support received from the EU for a summer school

This led to an operation budget in excess of 1.4 MF, taking into account a carry-forward from the 2000 operation budget of 1.6 MF.

2001 - Investment budget

a) Expenditure concerned mainly :

- scientific equipment, in particular for the "new generation" receivers for the Plateau de Bure, and for computer hardware.
- safety equipment for the Plateau de Bure and vehicles to ensure the safety of the transport to Bure

b) Income

Significant amounts of money have been transferred from the 1999 and 2000 investment budget.

Taking into account the carry-forward from the years 1999 and 2000, the 2001 investment budget was in excess by about 12.2 MF. Of this sum 8.8 MF correspond to outstanding commitments where orders have been placed but not yet paid.

BUDGET 2001
(in FRF)

2001 - EXPENDITURE

Budget heading	Approved	Actual
Operation / Personnel	44 090 000	42 487 126
Operation / other items	17 910 000	19 320 872
TOTAL OPERATION	**62 000 000**	**61 807 997**
Investment (general + 6th antenna)	25 069 122	12 837 503
TOTAL EXPENDITURE excl. VAT	***87 069 122***	***74 645 500***
VAT	5 415 931	5 415 931
TOTAL EXPENDITURE incl. VAT	***92 485 053***	***80 061 431***

2001 - INCOME

Budget heading	Approved	Actual
CNRS contributions	32 454 501	32 454 501
MPG contributions	32 454 501	32 454 501
IGN contributions	4 143 128	4 143 128
TOTAL CONTRIBUTIONS	***69 052 130***	***69 052 130***
Carry forward from 1999 and 2000 (Op+Inv.)	16 416 992	16 416 992
IRAM's own income	1 600 000	2 876 786
TOTAL INCOME excl. VAT	***87 069 122***	***88 345 908***
CNRS contribution for VAT (20,6%/19,6%) *	5 415 931	5 415 931
TOTAL INCOME incl. VAT	***92 485 053***	***93 761 839***

BUDGET PROVISIONS 2002

(in EUROS)

2001 - EXPENDITURE

Budget heading	Approved
Operation / Personnel	6 907 500
Operation / other items	2 620 000
TOTAL OPERATION	**9 527 500**
Investment - general	2 486 840
TOTAL INVESTMENT	**2 486 840**
TOTAL EXPENDITURE	***12 014 340***
VAT (19,6%)	825 653
TOTAL EXPENDITURE incl. VAT	***12 839 993***

2001 - INCOME

Budget heading	Approved
CNRS contributions	4 947 657
MPG contributions	4 947 657
IGN contributions	631 616
TOTAL CONTRIBUTIONS	**10 526 929**
IRAM's own income not less than	225 015 *
Carry forward from 2000/2001	1 200 216
TOTAL INCOME excl. VAT	***11 952 160***
CNRS contribution for VAT (19,6)	825 653
TOTAL INCOME incl. VAT	***12 777 813***

* 225.015,00 EUROS is the minimum expected level of income. If 9.527.500,00 EUROS were effectively needed for operation, IRAM will have to increase the own income by 61.180,00 EUROS, or, if this is not possible,IRAM is authorised to transfer an amount of up to 62.180,00 EUROS from the investment budget to the operating budget. This will reduce the authorised level of expenditures for investments accordingly.

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

0.1 JANUARY 02 – JANUARY 16

Ident.	Title	Freq. (GHz)	Authors
218.00	Investigating the connection between molecular ices and gas phase chemistry	85,86,109,144,154 ,219,231	Gerin, Dartois, D'Hendecourt, Roueff, Pineau des Forets
201.00	Spectras survey of CRL618 at millimeter wavelengths	160,242,255,267	Cernicharo, Pardo, Guélin, Rodriguez, Neri
207.00	Heavy molecular species in AGB and post-AGB stars : from acetylene to aromatics	82,92	Cernicharo, Guélin, Pardo, Neri
147.00	High latitude CO observations of NGC 5775	114,229	Lee, Leon, Garcia-Burillo, Irwin
218.00	Investigating the connection between molecular ices and gas phase chemistry	85,86,109,144,154 ,219,231	Gerin, Dartois, D'Hendecourt, Roueff, Pineau des Forêts
148.00	Search for CO+ in AGNs	85,88,117,115,111 ,230	Fuente, Black, Martin-Pintado, Rodriguez-Franco, Garcia-Burillo
201.00	Spectral survey of CRL618 at millimetre wavelengths	160,242,255,267	Cernicharo, Pardo, Guélin, Rodriguez, Neri
207.00	Heavy molecular species in AGB and post-AGB stars : from acetylene to aromatics	82,92	Cernicharo, Guélin, Pardo, Neri

0.2 JANUARY 16 – JANUARY 30

Ident.	Title	Freq. (GHz)	Authors
	Coordinated Bolometer Observations		
157.00	Investigating the composition of the ices in Comet C/1999 T1	88,147,168,230,26 5271	Crovisier, Biver, Bockelée-Morvan, Colom, Henry, Lecacheux, Despois, Lis, Moreno

0.3 JANUARY 30 – FEBRUARY 13

Ident.	Title	Freq. (GHz)	Authors
113.00	A search for dusty disks around low mass young stars	Bolometer	Simon, Dutrey, Guilloteau, White, Gueth, Baraffe
112.00	Star formation at z =5.8 : measuring the star formation properties of SDSS1044-0125	Bolometer	Isaak, McMahon, Priddey
157.00	Investigating the composition of the ices in comet C/1999 T1	88,147,168,230,26 5271	Crovisier, Biver, Bockelée-Morvan, Colom, Henry, Lecacheux, Despois, Lis, Moreno
151.00	Dust thermal emission from the reddest galaxies of the universe	Bolometer	Cimatti, Andreani, Daddi, Roettgering
Δ04.00	Deep spectrum radio source 0305+35		Roettgering
Δ03.00	1mm monitoring of the gamma ray flaring Mrk421		Henri
210.00	Obscured star formation in the early universe	Bolometer	Roettgering, van Breugel, Reuland
	Coordinated Bolometer Observations		

0.4 FEBRUARY 13 – FEBRUARY 27

Ident.	Title	Freq. (GHz)	Authors
	Coordinated Bolometer Observations	Bolometer	Bolometer Group

0.5 FEBRUARY 27 – MARCH 13

Ident.	Title	Freq. (GHz)	Authors
Δ03.00	1mm monitoring of the gamma ray flaring Mrk421		Henri
210.00	Obscured star formation in the early universe	Bolometer	Roettgering, van Breugel, Reuland
	Coordinated Bolometer Observations		
113.00	A search for dusty disks around low mass young stars	Bolometer	Simon, Dutrey, Guilloteau, White, Gueth, Baraffe
Δ02.00	Comet Linear		Altenhoff, Kreysa, Menten, Thum
Δ01.00	Confirmation of the detection of CO+ in Cyg A		Fuente
	Coordinated Bolometer Observations		
146.00	CO distribution and outflow in the post-starburst dwarf galaxy NGC 1569	115,230	Mühle, Hüttemeister, Klein, Fritz

0.6 MARCH 13 – MARCH 27

Ident.	Title	Freq. (GHz)	Authors
	Coordinated Bolometer Observations		
Δ05.00	1.2mm survey of luminous Z>4 QSOs		Omont, Cox, Bertoldi, McMahon
207.00	Heavy molecular species in AGB and post-AGB stars : from acetylene to aromatics	82,92	Cernicharo, Guélin, Pardo, Neri
161.00	Massive star formation in the galactic mini-starburst W43	86,98,110,230,241, 244	Motte, Schilke, Walsh
162.00	On the origin of D_2CO in proto-stellar environment	85,110,140,216,23 1 281	Loinard, Castets, Ceccarelli, Lefloch, Benayoun, Vastel, Tielens, Caux, Bacmann
	VLBI Observations		

0.7 MARCH 27 – APRIL 10

Ident.	Title	Freq. (GHz)	Authors
207.00	Heavy molecular species in AGB and post-AGB stars : from acetylene to aromatics	82,92	Cernicharo, Guélin, Pardo, Neri
161.00	Massive star formation in the galactic mini-starburst W43	86,98,110,230,241, 244	Motte, Schilke, Walsh
125.00	Probing the existence of X-ray dominated regions around low-mass protostars	115, 208	Lefloch, Ceccarelli, Loinard, Castets, Tielens
109.00	Millimeter study of the HH 222 region	115,230,110,220, 109,219	Castets, Reipurth
126.00	Molecular gas in Abell 262 and Abell 1367 cluster galaxies	115, 230	Eckart
	3mm and 2mm VLBI Observations		

0.8 APRIL 10 – APRIL 24

Ident.	Title	Freq. (GHz)	Authors
	2mm VLBI Observations		
108.00	The chemical structure of B68 from 0 to 30 mags of extinction	93,109,112,230	Lada, Bergin, Alves
179.00	A search in redshift space for molecular absorption lines towards 3C446 at z = 1.404	84, 223	Wiklind, Combes, Baker
144.00	Probing the nuclei of pre-star-forming cores	93,154,231,279	Zucconi, Walmsley, Caselli, Tafalla, Myers
182.00	The degree of ionisation in starless cores : DCO+ and $H^{13}CO^{+}$	85,86,144,216,260	Zucconi, Guélin, Walmsley, Caselli, Tafalla, Myers
186.00	The physics of spectral-line polarization in molecular cores	115, 110, 86	Greaves, Thum
131.00	A search for rapid polarization variations in IDV sources	Polarimeter	Cimo, Thum, Krichbaum, Fuhmann, Kraus, Witzel, Zensus

0.9 APRIL 24 – MAY 8

Ident.	Title	Freq. (GHz)	Authors
Δ06.00	Bolometer observations of gamma-ray burst afterglows		Frail, Galama, Kulkarni, Menten, Bertoldi
183.00	Jets, molecular outflows, and infall in Orion protostars	230,217,115,86,26 7140,93	Stanke, McCaughrean, Menten, Nürnberger, Schilke, Smith, Zinnecker
102.00	Determination of the CO production rate of comet 1999j2	88, 230	Festou, Paubert, Parker, Stern
	Coordinated Bolometer Observations		
159.00	A 2mm line survey of the starburst galaxy NGC 253	130, 170	Mauersberger, Henkel, Martin-Pintado, Garcia-Burillo

0.10 MAY 8 – MAY 22

Ident.	Title	Freq. (GHz)	Authors
	Coordinated Bolometer Observations		
159.00	A 2mm line survey of the starburst galaxy NGC 253	130, 170	Mauersberger, Henkel, Martin-Pintado, Garcia-Burillo
169.00	The evolution of dense cores forming the youngest protostars in Serpens	109, 112, 219, 224	Ladd, Fuller, Mercer
136.00	Spatial distribution of the molecular gas in the dwarf galaxy Mrk 86	115, 230	De Paz, Sanchez-Contreras, Zamorano, Silich
087.00	Gas content and star formation efficiency of dwarf galaxies	115, 230	Albrecht, Chini, Lemke
060.01	Carbon chains in photo-dissociation regions	85, 87, 97, 145,174 262	Fossé, Gerin, Cernicharo, Cesarsky, Lequeux

0.11 MAY 22 – JUN 5

Ident.	Title	Freq. (GHz)	Authors
142.00	Stellar SiO masers in the galactic plane	86, 212	Habing, Omont, Sjouwermann, Messineo, Menten
041.01	Chemistry in WR environments	86,98,113,130,147 217,244	Rizzo, Martin-Pintado
020.01	Molecular gas in tidal dwarf galaxies : beyond detection	110,113,115,220 228,230	Braine, Duc, Lisenfeld, Leon, Brinks, Charmandaris
077.01	Search for CO in low surface brightness galaxies	108,109,214,217 218	O'Neil, Hofner
032.01	Search for CO+ in AGNs (II)	115,114,225,234, 88, 89	Fuente, Black, Martin-Pintado, Rodriguez-Franco, Garcia-Burillo, Rodriguez-Fernandez
091.01	Study of the chemical evolution of the molecular gas surrounding intermediate mass stars		Fuente, Martin-Pintado, Bachiller, Rodriguez-Franco, Rizzo

0.12 JUN 5 – JUN 19

Ident.	Title	Freq. (GHz)	Authors
009.01	Completion of a study to probe the role of H_2S in the evolution of molecular outflows	168,216,104,241,99 138	Codella, Bachiller, Saraceno, Nisini
008.01	M16 : continuum from Elephant Trunks, clumps, and globules	Bolometer	Ungerechts, Sievers
Δ07.00	Baseline correction in NGC 1569 bolometer maps		Lisenfeld
058.01	The influence of local environment on molecular gas properties in the low metallicity dwarf starburst galaxies	115, 110, 109	Hüttemeister, Walter, Taylo
011.01	Very cold dust in spiral and irregular galaxies	Bolometer	Krause, Lemke, Stickel, Klaas
Δ11.00	CO(1-0) in NGC 4666		Lisenfeld
093.01	Mars : Search for O3, and equinoxial dynamics	115,230,220,239 237,231	Encrenaz, Lellouch, Paubert, Moreno
023.01	The distribution of molecular gas in the tidal arms of the interacting M81 triplet	115, 230	Heithausen, Walter, Thilker

0.13 JUN 19 – JULY 03

Ident.	Title	Freq. (GHz)	Authors
003.01	Metal carbides in AGB and post-AGB stars : searches for NaC, CoC, and NiC	102,114,152,166 205,229	Savage, Ziurys, Highberger
159.00	A 2mm line survey of the starburst galaxy NGC 253	130, 170	Mauersberger, Henkel, Martin-Pintado, Garcia-Burillo
044.01	Search for molecular absorption in damped Lyman-alpha systems (DLA)	82,81,80,93,82,105	Combes, Wiklind, Chengalur, Kanekar
089.01	Dense molecular gas in the center of the radio-galaxy NGC 3718	88, 229	Hartwitch, Eckart, Leon
060.01	Carbon chains in photo-dissociation regions	85,87,91,97,145, 174,262	Fossé, Gerin, Cernicharo, Cesarsky, Lequeux
047.01	A deep CO survey of the most powerful radio galaxies in the local universe	111,112,115,224 230	Lim, Combes, Leon, Van-Trung Dinh
054.01	The nuclear bar of NGC 5728 : fueling the AGN ?	114, 228	Combes, Leon
037.01	The mystery of cooling flows revisited	104,108,111,209 216,223	Salomé, Combes

0.14 JULY 03 – JULY 17

Ident.	Title	Freq. (GHz)	Authors
024.01	The physical properties of the molecular gas within the spiral arms of M51 : ^{13}CO and $C^{18}O$ zero spacing	109, 110	Weiss, Schinnerer, Aalto, Scoville
085.01	An ionization survey of class O sources	86,144,216	Muders, Uchida
Δ13.01	C/2001 A2 (Linear)		Bockelee-Morvan
048.01	CO in the compact high-velocity cloud HVC125+41-207	115, 230	Brüns Kerp
090.01	Molecular clouds in the disk-halo interface	115, 110, 230	Heithausen, Kerp, Weiss
146.00	CO distribution and outflow in the post-starburst dwarf galaxy NGC 1569	115,230	Mühle, Hüttemeister, Klein, Fritz
036.01	Dwarf galaxies in Stephan's Quintet : the effect of galaxy interactions on the molecular gas	107,112,113,215 225,226	Lisenfeld, Braine, Duc, Charmandaris, Leon, Brinks

0.15 JULY 17 – JULY 31

Ident.	Title	Freq. (GHz)	Authors
146.00	CO distribution and outflow in the post-starburst dwarf galaxy NGC 1569	115,230	Mühle, Hüttemeister, Klein, Fritz
Δ12.01	Zero spacing		Pascucci
050.01	The mm-peaked-blazars. Searching targets for INTEGRAL	87,142,228	Krichbaum, Ungerechts, Lisenfeld, Wagner, Britzen, Beckert, Kraus, Cimo, Fuhrmana
060.01	Carbon chains in photo-dissociation regions	85,87,91,97,145, 174,262	Fosse, Gerin, Cernicharo, Cesarsky, Lequeux

0.16 JULY 31 – AUGUST 14

Ident.	Title	Freq. (GHz)	Authors
070.01	CO observations of polar rings	113,112,226,225	Combes, van Driel, Arnaboldi, Sparke
014.01	Variability of molecular absorption lines at z=0.25	92,142,143,213,21 4	Wiklind, Combes
037.01	The mystery of cooling flows revisited	104, 108,111,209, 216,223	Salomé, Combes
041.01	Chemistry in WR environments	86,98,113,130,147, 217,244	Rizzo, Martin-Pintado
Δ07.01	Unusually broad $H_{13}CO+$ in L1512		Schmid-Burgk, Muders
Δ14.01	Dust in a highly redshifted type II QSO		Wiseman
Δ15.01	HD-112μ in absorption		Ceccarelli
084.01	A search for molecular absorption lines towards a QSO at z=0.915	81,115,149-163	Wiklind, Combes
052.01	Is molecular deuteration in dark cloud cores caused by CO depletion ?	110,140,218,231 281	Bacmann, Ceccarelli, Castets, Loinard, Lefloch
Δ09.01	CS(2-1) rest frequency		Pagani
Δ16.01	A search for dusty disks around low mass young stars		Simon, Dutrey

0.17 AUGUST 14 – AUGUST 28

Ident.	Title	Freq. (GHz)	Authors
	2 weeks of Coordinated Heterodyne Observations		Coordinator : Ute Lisenfeld

0.18 AUGUST 28 – SEPTEMBER 11

Ident.	Title	Freq. (GHz)	Authors
040.01	Dynamical signatures of a MHD instability along a dense filament	89,110,220,230	Falgarone, Hily-Blant, Phillips, Pety, Pineau des Forêts
003.01	Metal carbides in AGB and post-AGB stars : searches for NaC, CoC and NiC	102,114,152,166 205,229	Savage, Ziurys, Highberger

0.19 SEPTEMBER 11 – SEPTEMBER 25

Ident.	Title	Freq. (GHz)	Authors
002.01	A search for metal chloride molecules in proto-planetary nebulae	91,143,234,273,10 2 131	Highberger, Savage, Halfen, Ziurys
057.01	Support observations of deep space 1 and ODIN investigations of comet 19P/Borelly	88,145,147,225,24 4 265	Bockelee-Morvan, Biver, Colom, Crovisier, Henry, Lecacheux, Festou, Lis, Moreno, Paubert
004.01	A search for ZnCN towards IRC+10216	131,139,146	Ziurys, Highberger, Savage, Guélin
Δ15.01	HD-112µ in absorption		Ceccarelli
025.01	Freezing out of molecules onto dust grains in IC 5146	86,93,113,144,216 226	Kramer, Lada, Walmsley, Bergin

0.20 SEPTEMBER 25 – OCTOBER 9

Ident.	Title	Freq. (GHz)	Authors
034.01	Dynamical state of dust-continuum condensations in the NGC 2068 protocluster	85,88,93,104,144 216,267	Belloche, André, Motte, Bontemps
069.01	Tracing the infall history of low-mass embedded protostars	86,88,93,137,145 219,224	André, Belloche, Yun, Despois
073.01	Different evolutionary stages in the high mass YSO G24.78+0.08	110,147,220,96,241	Cesaroni, Codella, Furuya, Testi

0.21 OCTOBER 9 – OCTOBER 23

Ident.	Title	Freq. (GHz)	Authors
082.01	Iron and Magnesium in molecular clouds	88,160,240,102,153	Walmsley, Bachiller, Pineau des Forêts, Schilke
043.01	Chemistry in disks around Herbig Ae stars	98,113,219,230,93 256	Henning, Ligner, Schreyer, Klein, Bacmann
	Coordinated Bolometer Observations		Coordinator : Ute Lisenfeld

0.22 OCTOBER 23 – NOVEMBER 6

Ident.	Title	Freq. (GHz)	Authors
	Coordinated Bolometer Observations		Coordinator : Ute Lisenfeld
031.01	Continuum observations of Comet C/2000 WM1 (LINEAR)	Bolometer	Altenhoff, Bertoldi, Menten, Thum, Sievers
027.01	A CO survey of low surface brightness spiral galaxies	115,230	Matthews, Gao, Combes
	VLBI Observations		
088.01	A star formation episode in the IC 348 cluster	93,115,219,230	Tafal, Kumar, Bachiller
026.01	Understanding molecular depletion in starless cores	140,150,211,99,158 241	Tafalla, Caselli, Myers, Walmsley

0.23 NOVEMBER 6 – NOVEMBER 20

Ident.	Title	Freq. (GHz)	Authors
026.01	Understanding molecular depletion in starless cores	140,150,211,99,158 241	Tafalla, Caselli, Myers, Walmsley
092.01	The outflow powered by the newly discovered Class O source 16293E	89	Loinard, Castets, Ceccarelli, Caux
068.01	The structure of solar type protostars	96,241,110,245,145	Ceccarelli, Maret, Caux, Castets, van Dishoeck, Jorgensen, Tielens, Loinard
086.01	Doubly deuterated molecules in dense ammonia cores	85,93,110,145,174 218	Roueff, Loinard, Gerin, Ceccarelli, Castets

0.24 NOVEMBER 20 – DECEMBER 04

Ident.	Title	Freq. (GHz)	Authors
109.01	Comet C/2000 WM1 (LINEAR) : the composition of nucleus ices	88,145,147,157,168230	Crovisier, Bockelee-Morvan, Colom, Henry, Lecacheux, Biver, Lis, Moreno, Paubert
114.01	Search for molecular gas towards infrared quasars	83,85,110,112,167, 250	Andreani, Tacconi, Cristiani, Bianchi
401.01	MAMBO Observing pool Nb. 1		

0.25 DECEMBER 04 – DECEMBER 18

Ident.	Title	Freq. (GHz)	Authors
401.01	MAMBO Observing pool Nb. 1		
402.01	MAMBO Observing pool Nb. 2		

0.26 DECEMBER 18 – JANUARY

Ident.	Title	Freq. (GHz)	Authors
403.01	MAMBO Observing pool Nb. 3		
404.01	MAMBO Observing pool Nb. 4		
126.01	The dust-enshrouded formation of massive elliptical galaxies	Bolometer	Ivison, Dunlop, Bertoldi, Carilli, Lutz, Eales, Greve, Fox
127.01	Molecular outflows in a sample of ultracompact HII regions	98,219	Feldt, Henning, Klein, Pascucci, Schreyer, Stecklum

7. ANNEX I: TELESCOPE SCHEDULES / 7.2 PdB Intererferometer

Ident.	Title	Line	Authors
K027	Physical properties of protoplanetary disks around Herbig Ae Stars 12	HCO+(1-0) CO(2-1)	A.Dutrey S.Guilloteau E.Dartois F.Gueth
K028	Detection of CO in the lensed Lyman break galaxy cB58	12CO(1-0) 12CO(2-1)	A.Baker L.Tacconi R.Genzel M.Lehnert D.Lutz
K029	Measuring the high-velocity molecular emission in PPNe	12 CO(1-0) 12 CO(2-1)	J.Alcolea A.Castro-Carrizo V.Bujarrabal R.Neri
K02F	A systematic search for high-mass protostars zooming in on IRAS 19217+1651 and IRAS 20293+3952	SiO(2-1) 12CO(2-1)	H.Beuther F.Gueth K.Menten P.Schilke T.Sridharan
K030	Completing a CO survey of gravitational lenses	12CO(4-3) 12CO(3-2) 12CO(2-1)	R.Barvainis D.Alloin R.Antonucci M.Bremer
K031	Search for HOC + and CO + in diffuse clouds	HOC+(1-0) 12CO+	H.Liszt R.Lucas J.Black
K032	Identification of MAMBO millimeter sources	Cont3mm Cont1mm	H.Dannerbauer F.Bertoldi K.Menten E.Kreysa D.Lutz M.Lehnert L.Tacconi R.Genzel C.Carilli F.Owen
K034	Probing infall in Class 0 young stellar objects with inverse P-Cygni profiles	N2H+(1-0) H2CO(3-2)	J.Di Francesco P.Myers D.Wilner
K035	The origin of elliptical galaxies	Cont1mm	S.Eales W.Gear F.Hammer S.Lilly L.Dunne D.Clements
K037	Testing the multi-phase gas properties in CSOs	HCO+(1-0) HCO+(4-3)	A.Peck K.Menten P.Schilke
K038	Interferometric observations of CO and CO + 12 in Cygnus A 12	CO(1-0) 12CO+ CO+(2-1)	A.Fuente J.Black J.Mart'in-Pintado A.Rodriguez-Franco S.Garcia-Burillo P.Planesas
K039	6C1909+72: a cluster-dominant galaxy at z = 3:5	12 CO(4-3) Cont1mm	R.Ivison P.Papadopoulos I.Smail D.Hughes J.Dunlop
K03B	Confirming a submm-selected protocluster at z = 3:8	12CO(4-3) 12CO(9-8)	R.Ivison D.Downes I.Smail J.Dunlop
K041	Identifying the counterparts of submm galaxies: star formation at high redshift	Cont3mm Cont1mm	D.Lutz J.Dunlop D.Hughes M.Rowan-Robinson S.Serjeant S.Oliver R.Mann R.Ivison L.Tacconi R.Genzel D.Rigopoulou P.Andreani
K043	A high resolution survey of molecular gas in the Galaxy	HCO+(1-0) CS(5-4)	A.Peck P.Schilke K.Menten

K044	Nuclei of galaxies: gas dynamics and AGN fueling	12CO(1-0) 12CO(2-1)	S.Garcia-Burillo F.Combes A.Eckart L.Tacconi L.Hunt S.Leon A.Baker P.Englmaier F.Boone E.Schinnerer R.Neri
K048	V380OriNE -- A cosmic garden hose	12CO(1-0) N2H+ 12CO(2-1) N2H+	T.Stanke C.Davis F.Gueth M.Caughrean K.Menten D.N¨urnberger M.Smith H.Zinnecker
K04A	CO observations of the protoplanetary nebula Frosty Leo	12CO(1-0) 12CO(2-1)	V.Bujarrabal R.Sahai C.S'anchez-Contreras A.Castro-Carrizo J.Alcolea
K04E	Structure in the dust disk around Vega	Cont1mm 12CO(2-1)	D.Wilner M.Holman P.Ho
K050	Probing the nucleosynthesis in the young Universe	12C34S 12C32S H12CO+ H13CO+ HCN HC15N H13CN H15NC HN13C 13C32 S	S.Muller M.Dumke M.Gu'elin R.Lucas F.Combes T.Wiklind
K052	SiO emission in the HH212 young outflow	SiO(2-1) SiO(5-4)	F.Gueth A.Dutrey S.Guilloteau P.Schilke
K053	Photochemistry and temperature gradient in the DM Tau disk	HCN(1-0) 13CO(2-1)	E.Dartois A.Dutrey S.Guilloteau H.Wiesemeyer M.Gu'elin
K055	The heart of 05358+3543 -- origin of a massive outflow	C34S(2-1) 12CO(2-1)	P.Schilke H.Beuther F.Gueth K.Menten
K057	The circumstellar disk of the embedded source HH30	13CO(1-0) 13CO(2-1)	F.Gueth A.Dutrey S.Guilloteau
K05A	CO search in seven high redshift PSS quasars	12CO(4-3) Cont1mm	P.Cox A.Omont F.Bertoldi J.Djorgovski K.Isaac R.McMahon
K05D	Molecular gas in a representative sample of ard nearby quasars	12CO(1-0)	F.Casoli L.Loin
K05E	Mapping the HCN spatial distribution in Jupiter's stratosphere	HCN(1-0)	R.Moreno A.Marten G.Paubert
K 1	Monitoring of the unusually bright GRB 010222	Cont3mm	M.Bremer A.Castro-Tirado
K 2	Millimeter Observations of the soft gamma-ray repeater SGR 1900+14	Cont3mm	A.Castro-Tirado M.Bremer

L001*?	Structure and kinematics of the warped molecular gas disk in the LINERNGC 3718	12CO(1-0) 12CO(2-1)	A.Eckart M.Hartwich S.Leon
·L002	Search for evolved disks in pre-main—sequence stars of intermediate mass	Cont3mm Cont1mm	A.Natta R.Neri L.Testi
L003	Tracing diffuse molecular gas in the outer Galaxy	HCO+(1-0)	R.Lucas H.S.Liszt
L005	Nuclei of galaxies: gas dynamics and AGN fuelling	12 CO(1-0) 12 CO(2-1)	S.Garcia-Burillo F.Combes A.Eckart L.Tacconi L.Hunt S.Leon A.Baker P.Englmaier F.Boone E.Schinnerer R.Neri
L007	Molecular gas and dust at z = 3:91	HCN(5-4) H2O CI(3P1-3P0)	T.Wiklind D.Downes D.Wilner R.Neri
L009	Mars' middle atmosphere dynamics at equinox	12CO(1-0) 12CO(2-1)	E.Lellouch R.Moreno S.Guilloteau T.Encrenaz F.Forget F.Jegou
L00A	CO search in High Redshift PSS Quasar	12CO(4-3) Cont1mm	P.Cox A.Omont F.Bertoldi J.D.Djorgovski K.Isaak R.McMahon
00B*	Dynamics of a double--barred system in the late--type barred galaxy NGC 3359	12CO(1-0)	M.Sempere S.Garcia-Burillo F.Combes
L00C	Widespread SiO emission in the nucleus of IC 342	SiO(2-1) H13CO+	S.Garcia-Burillo A.Fuente J.Mart'in-Pintado R.Neri N.J.Rodriguez-Fernandez
L00E	X-ray absorbed QSO/ULIRGs: implications for coeval galaxy and QSO evolution	12CO(2-1) 12CO(3-2)	R.J.Ivison M.Page J.Stevens
L00F	CO emission for dusty radio galaxies at very high redshifts	12CO(4-3) 12CO(5-4) Cont1mm	C.deBreuck A.Omont B.Rocca-Volmerange W.deVries M.Reuland W.vanBreugel H.R¨ottgering M.Wright R.Neri
L012	Molecular gas in the counter--rotating disk of NGC 4418	12CO(1-0) 12CO(2-1)	A.Baker L.Tacconi R.Genzel P.Englmaier
L013	19410+2336: a mm- and X-ray-study of a high-mass protostellar object	12CO(1-0) 12CO(2-1)	H.Beuther P.Schilke K.Menten J.Kerp
L016	Molecular gas in distant, ultraluminous submillimetre-selected galaxies	12CO(2-1) 12CO(3-2) 12CO(4-3) 12CO(7-6)	D.Downes P.M.Solomon R.J.Ivison I.Smail A.W.Blain
L018	The diskwind of HD 45677	H39α 12CO(1-0)	C.Thum

L01C	Probing the nucleosynthesis in the young Universe	C34S C32S HCO+ DCO+ HC15N HN13C DNC	S.Muller M.Dumke M.Guelin R.Lucas F.Combes M.Gerin T.Wiklind
L01D*	CO observations of z=1.5 hyperluminous IR quasars	12 CO(2-1)	C.Willott S.Rawlings
L021	Identification of highest redshift Millimeter Sources	Cont3mm Cont1mm	H.Dannerbauer F.Bertoldi K.Menten D.Lutz M.Lehnert L.Tacconi R.Genzel C.Carilli F.Owen
L02A	Structure of Contracting Starless Core L694-2	N2H+(1-0)	D.Wilner D.Harvey J.Alves P.Myers T.Bourki
L041	CO emission from dusty radio galaxies at very high redshifts	12CO(4-3)	C.DeBreuck A.Omont B.Rocca-Volmerange R.Neri M.Reuland W.vanBreugel W.deVries H.Röttgering
L045	The mysterious origin of Brown Dwarfs	12CO(1-0) 12CO(2-1)	J.Bouvier G.Duvert C.Dougados F.Menard E.Martin
L046*	A search for CO emission from the dusty host galaxy of GRB010222	12CO(2-1) 12CO(5-4)	C.Carilli F.Bertoldi A.Peck D.Frail E.Berger S.Kulkarni
L048*	A Multi--Transition Absorption Study of the Collapsing IRAS 4 Envelopes	H 2 CO CS(5-4)	J.Di Francesco P.Myers D.Wilner
L04B	Identifying the counterparts of submm galaxies: Star formation at high redshift	Cont3mm Cont1mm	D.Lutz J.Dunlop J.Peacock R.Mann R.Ivison S.Oliver M.Rowan-Robinson S.Serjeant L.Tacconi R.Genzel D.Rigopoulou P.Andreani
L054	Resolution of the sub--mm triple image in A2218	12CO(4-3) Cont1mm	P.van der Werf J.-P.Kneib A.Blain R.Ivison I.Smail
L05A	Weighting the very low/-mass stars	12CO(1-0) 12CO(2-1)	A.Dutrey M.Simon S.Guilloteau F.Gueth R.White I.Baraffe
L05F*	Tracing Infall and Differential Rotation in the Class 0 Protostar IRAM 04191	N2H+(1-0) N2D+(3-2)	A.Belloche P.Andre D.Despois

L 1	CO search in PSS2322+19	12 CO(4-3)	P.Cox A.Omont F.Bertoldi J.Djorgovski K.Isaac R.McMahon
L 2	CO search in PSS2322+19	12 CO(5-4)	P.Cox A.Omont F.Bertoldi J.Djorgovski K.Isaac R.McMahon

* Projects close to completion on December 31

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A.J. Castro-Tirado, M. Bremer, et al.
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9. ANNEX III - IRAM Executive Council and Committee Members, January 2001

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