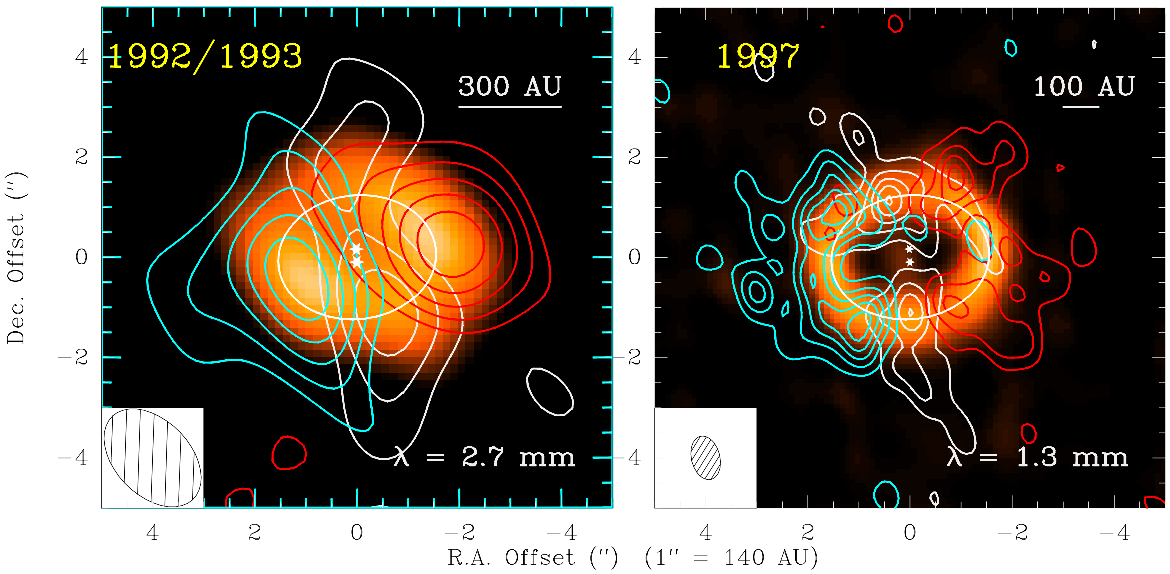
# IRAM Newsletter

## Contents



Number 39 April 30th, 1999

## Cover Picture




**Two images of the GG Tau circumbinary ring: 5 years of improvement on the IRAM interferometer.** The contours show the iso-intensity levels observed at $\simeq$ 5.5, 6.5 (systemic velocity) and 7.5 km.s$^{-1}$ in the $^{13}$CO $J = 1-0$ (**left**) and $J = 2-1$ (**right**) lines; the background shows the $\lambda$ 2.7-mm (left) and 1.3-mm (right) thermal dust emission. The stars give the position of the binary. Located in a hole within the Taurus cloud complex, GG Tau is a TTauri binary of separation 0.26″. Interferometric observations of the $^{13}$CO and dust $\lambda$ 2.7-mm emissions (**left**) revealed five years ago a large ($R_{out}$ ~800 AU), massive (0.15$M_\odot$) circumbinary disk of gas and dust, whose central $R = 180$ $AU$ have been cleared up by tidal effects (Dutrey et al. 1994). The disk was shown to be in Keplerian rotation around a binary star of mass $\simeq$ 1.3$M_\odot$. Subsequent near-IR observations, made at the CFHT with adaptive optics, confirmed the existence of the central hole and the value of inclination angle determined at mm wavelengths (Roddier et al. 1996). In the last 5 years, the sensitivity of the IRAM interferometer has increased by a factor of 3 at $\lambda$ 3-mm in 5 years, while access to the $\lambda$ 1-mm band and baseline extensions have increased the angular resolution by a factor of 3. The new IRAM observations (**right**) have a resolution of $\simeq$ 0.6″. They further resolve the circumbinary disk in the $^{13}$CO(2–1) line and in the $\lambda$ 1.3-mm continuum and show that 80 % of the disk mass is concentrated in a narrow ring of width 80 AU. An extrapolation of this example to the gains in sensitivity and resolution that ALMA will provide shows it will be possible to study protoplanetray disks at the scale of planetary formation.

## Calendar

**April 30th, 1999** IRAM SAC meeting

**June 17-18th, 1999** IRAM Executive Council meeting

**July 5th, 1999** Next IRAM Newsletter deadline

**Sept 6 th, 1999 24:00h (MET):** Deadline for the submission of observing proposals for the period Nov. 15th, 1999 to May 15, 1999

**Oct. 12,13th 1999** Program Committee meeting

# Personnel Changes, New Tasks Assignments

As of April 1st, 1999 Rainer MAUERSBERGER has been appointed as the new Station Manager in Granada. He succeeds Wolfgang WILD who has served in this capacity since 1993.

Following the signature in December of the MoU between ESO, CNRS, MPG, NFRA, and PPARC for the construction of a large southern hemisphere millimeter array as a joint European/US project in which also Japan may be participating in the future, first decisions have been taken by the European Coordinating Committee (ECC) about the management structure on the European side. After the appointment of Dr.Richard KURZ, ESO as the European Project Manager, Stephane GUILLOTEAU has been nominated as the European Project Scientist.

The consequences of this appointment as well as the involvement of other IRAM staff members during Phase 1 of the ALMA project (Atacama Large Millimeter Array, formerly LSA/MMA) will have, of course, have to be analysed. During its recent meeting on April 30th, 1999 in Granada the IRAM-SAC has already discussed the matter. During the June 1999 IRAM-Council meeting it will be discussed further, and decisions will have to be taken.

*Michael Grewing*

# News from the 30-m telescope

## *New 30-m Telescope Manual*

Version 2.0 of *The 30m Telescope Manual* is now available at the IRAM Granada web pages. Many things have changed at the 30m telescope since the first version has been released in October 1995. Among the most noticeable changes for observers were certainly the new receiver cabin, larger and more sensitive bolometers, the introduction of a spectral-line on-the-fly observing mode, better communication infrastructure, more and faster computers, and remote observing from Grenoble - to name only a few. All these improvements and changes made an update necessary.

Version 2.0 of The 30m Manual can be downloaded in postscript format (about 100 pages, 2.9 Mbyte) from the IRAM Granada web pages. An HTML version (for online reading) is planned.

*Wolfgang Wild*

## *Receiver tunings*

The new generation of receivers turned out to be very reliable and easy to tune. Tuning is done automatically or by the operator; only very little time is lost due to receiver problems. Therefore we have decided that there will be no receiver engineer on Pico Veleta during the weekends anymore. An engineer will, however, be on standby during weekend days, and, in case of problems, can be at the telescope within 2 hours. Observers who need the presence of a receiver engineer should contact Santiago Navarro (email: navarro@iram.es) or Dave John (email: john@iram.es) well in advance.

## *Visitors' office in Granada*

To make the stay at our Granada offices more productive, we now have a visitor's office equipped with two LINUX computers, a printer and a telephone in our Granada office building. There will be documentation about the telescope, our computers and the available software. The computers can be used as X-terminals, and also for Telnet, FTP, to use LaTeX and read e-mail. You will find it upstairs behind the library.

*Rainer Mauersberger*

## *New control system for the 30-m Telescope*

In the near future many hardware components of the control system for the 30-m telescope will be replaced by more modern equipment. This implies corresponding changes in the software. We have compiled a preliminary list of desirable features for a new system, which will complement the many successful features currently available.

Our goals are to:

1. improve current observing modes;
2. design and implement new observing modes;
3. optimize for mm-wavelength observations with a large single-dish telescope; and
4. prepare the system for future hardware.

We foresee a 'core' of features, that will be essential parts of the new system, including:

1. continuous data taking, e.g. fast on-the-fly observations;
2. remote observing, service observing, and flexibility of observing and scheduling;
3. observations with focal-plane arrays, both bolometers and heterodyne receivers; and
4. observing modes using the full parameter space of the 'wobbler'.

At this time (April 1999) we are discussing several questions in detail in order to specify detailed requirements for the future system, and to study possible solutions.

All users of the 30-m are invited to comment on our plans.

Details and regular updates can be found on the WWW pages for this project:
http://www.iram.es/FutureControl30M/Main.html

*Hans Ungerechts,* email: ungerechts@iram.es

## News from the interferometer

### Observations

Snowstorms, winds and highly unseasonal temperatures have determined the weather this winter at Plateau de Bure. Nevertheless, all A-rated proposals are now completed with only a few exceptions, and a small number of (lucky) B-rated proposals was finally scheduled for observations. Because of springtime conditions, however, observations at 1.3-mm can now be carried out only during nighttime. We remind users of the Plateau de Bure interferometer that B-rated proposals which were not started have to be resubmitted again. The daily status of all ongoing projects is accessible on the Internet http://iram.fr/doc/project.html

*Roberto Neri*

### Antennas

The construction of the 6th antenna is proceeding very close to schedule. The photo, as of April 9th, shows the antenna in the hangar on Plateau de Bure: the pedestal and the transporter were already finished in February and work is now on progress on the yoke and on the receiver cabin. The thermal insulation of the yoke is underway and the installation of the main electrical equipment will be tackled in the days to come. The assembly of the 15-m reflector will start in September.

*Thierry Crouzet and Roberto Neri*

Figure 1: Counterweights were placed at the cabin level (on the front suspension and in the back of the receiver cabin) to set up the fine adjustment of the elevation block. Work on the protective covering of the pedestal and the yoke is already underway.

## Software

GILDAS software has evolved quite substantially since the original "SAS" program (later renamed LAS & CLASS) was written at the Groupe d'Astrophysique de Grenoble for the analysis of spectra from the POM-2 telescope.

GILDAS is now about 10 years old (some parts are 15 years old, others are only 2 years old), and has been ported to 5 operating systems (simultaneously or successively): RSX-11M, VAX-VMS, several Unix, MAC-OS and Windows-95/98. Because of short (Plateau de Bure antenna 6), medium (software upgrade of the 30-m, VLTI data reduction software), and (not so) long (ALMA) term projects, it is time to re-evaluate the future of GILDAS. A document has been written on this matter; it can be consulted at http://iram.fr/doc/evolution/evolution.html.

We have created an email distribution list (`gildas-user@iram.fr`) to facilitate interactions between users and the Gildas group. Please feel free to subscribe to that list, by sending to `listserv@iram.fr` an email message containing the line:
`SUBSCRIBE gildas-user` *your name and institution*
You will then be able to send e-mail to the list (`gildas-user@iram.fr`) to report problems, send suggestions, propose contributions, and in particular comment on the above document. Based on this document, first changes were made concerning the command monitor SIC; they are being used in Grenoble.

A new version of the GILDAS software (mar99) is available in our ftp area (ftp://iram.fr/dist/soft/). This version does not contain any of the changes just discussed (but we are confident that the next one will).

*Stéphane Guilloteau and Robert Lucas*

# Recommendations of the IRAM Program Committee

The IRAM program committee, chaired by Thierry Montmerle, convened in Grenoble on April 8 and 9, 1999 to discuss the proposals submitted for the summer 1999 scheduling period. A total of 71 proposals requesting 3378 hours were received for the 30-m telescope and 36 proposals were received for the interferometer. Considering technical periods, VLBI and, in the case of the interferometer, weather contingencies, both instruments are oversubscribed by a substantial factor.

**For the 30m telescope**, the committee gave the highest rating "A" to 28 proposals, and 20 proposals received backup status. One proposal, 39–99, was transferred to the interferometer. Like last summer, the committee accepted several proposals requesting more than 100 hours. The individual ratings are listed in the attached table (the proposal numbers were communicated to the PI of each proposal shortly after submission).

As usual, only part of the B proposals will be scheduled, depending on the scientific merit, right ascension range, and general aspects of balance. Owing to particularly strong demands for some right ascension ranges, even A–rated proposals may not always get all the time requested.

**30-m Telescope program ratings**

| A | | B | | C | |
|---|---|---|---|---|---|
| 02–99 | 42–99 | 04–99 | 53–99 | 01–99 | 40–99 |
| 08–99 | 43–99 | 05–99 | 58–99 | 03–99 | 41–99 |
| 11–99 | 44–99 | 07–99 | 60–99 | 06–99 | 48–99 |
| 14–99 | 46–99 | 10–99 | 65–99 | 09–99 | 57–99 |
| 15–99 | 49–99 | 19–99 | 68–99 | 12–99 | 61–99 |
| 17–99 | 52–99 | 20–99 | 70–99 | 13–99 | 63–99 |
| 18–99 | 54–99 | 21–99 | | 16–99 | 64–99 |
| 26–99 | 55–99 | 24–99 | | 22–99 | 71–99 |
| 27–99 | 56–99 | 32–99 | | 23–99 | |
| 28–99 | 59–99 | 34–99 | | 25–99 | |
| 29–99 | 62–99 | 45–99 | | 31–99 | |
| 30–99 | 66–99 | 47–99 | | 33–99 | |
| 36–99 | 67–99 | 50–99 | | 35–99 | |
| 37–99 | 69–99 | 51–99 | | 38–99 | |

**For the interferometer**, the programs were classified in A, A/B, B and C category. The A programs will be scheduled in priority, A/B programs will be scheduled if feasible. Further time, if it becomes available, will go to the B programs, taking into account scientific merit, crowding in certain right ascension ranges and general aspects of balance.

*R. Neri & C. Thum*

**Interferometer program ratings**
A: Accepted, A/B: Scheduled if feasible
B: Backup if available time, C: Rejected.

| Project | Rate | Project | Rate | Project | Rate |
|---|---|---|---|---|---|
| J001 | C | J002 | C | J003 | B |
| J004 | A | J005 | A/B | J006 | A |
| J007 | A | J008 | A | J009 | A/B |
| J00A | A/B | J00B | A/B | J00C | A† |
| J00D | C | J00E | B | J00F | B |
| J010 | C | J011 | A† | J012 | A |
| J013 | A | J014 | C | J015 | C |
| J016 | A | J017 | C | J018‡ | A/B |
| J019 | C | J01A | C | J01B‡ | A/B |
| J01C | B | J01D | A | J01E | B |
| J01F | C | J020 | B† | J021 | A |
| J022 | B | J023 | B | | |

† program accepted in one or more parts only.
‡ program will be carried out as a 'time-filler'.

Further information on individual projects are sent by letter.

| project | PI | Inst. | Rate | Subject | Contact |
|---|---|---|---|---|---|
| j004 | Schilke | MPIfR | A | YSO | H.Wiesemeyer |
| j006(i159) | Barvainis | REB | A | GAL | M.Bremer |
| j016 | Walter | Obs.Bonn | A | GAL | M.Dumke |
| j01d | Andreani | Obs.Padova | A | GAL | L.Loinard |
| j021 | Falgarone | ENS | A | GAL | E.Dartois |
| j009 | Kneib | OMP | A/B | GAL | R.Moreno |
| j00a | Feldt | MPIfR | A/B | YSO | D.Nuernberger |
| j00b | Tacconi | MPE | A/B | GAL | A.Dutrey |
| j003 | Antonucci | UCSB | B | GAL | D.Downes |
| j00e | Henning | Uni.Jena | B | YSO | A.Greve |
| j00f | Wiklind | Obs.Onsala | B | GAL | M.Guelin |
| j01c | Lutz | MPE | B | GAL | R.Lucas |
| j01e | Vollmer | Obs.Paris | B | GAL | D.Morris |
| j020 | Desert | Obs.Grenoble | B | GAL | R.Neri |
| j022 | Josselin | OAN | B | CSE | C.Thum |
| j023 | Schinnerer | MPE | B | GAL | M.Dumke |

## Local contacts for the period May–Nov. 1999

The e-mail address of your local contact is name@iram.fr (where name is truncated to the first 8 characters, e.g. wiesemey for Wiesemeyer or nurnberg for Nuernberger)

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

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

*Anne Dutrey*

## Scientific results in press

JETS AND HIGH-VELOCITY BULLETS IN THE ORION A OUTFLOWS. IS THE IRC2 OUTFLOW POWERED BY A VARIABLE JET

A. Rodríguez−Franco([1,2]), J. Martín−Pintado([2]), and T.L. Wilson([3,4])

([1])Departamento de Matemática Aplicada II, Sección departamental de Optica, Escuela Universitaria de Optica, Universidad Complutense de Madrid. Av. Arcos de Jalón s/n. E-28037 Madrid, Spain

([2])Observatorio Astronómico Nacional (IGN), Campus Universitario, Apdo. 1143, E-28800, Alcalá de Henares, Spain

([3])Max Planck Institut für Radioastronomie, Postfach 2024, D-53010 Bonn, Germany.

([4])Sub-mm Telescope Observatory, Steward Observatory, The University of Arizona, Tucson, Az, 85721.

*Abstract*:

We present high sensitivity maps of the High Velocity (HV) CO emission toward the molecular outflows around IRc2 and Orion–S in the Orion A molecular cloud. The maps reveal the presence of HV bullets in both outflows with velocities between 40-80 $\mathrm{km\,s^{-1}}$ from the ambient gas velocity. The blue and redshifted CO HV bullets associated with the IRc2 outflow are distributed in thin ($12'' - 20''$, $0.02 - 0.04$ pc) elliptical ring-like structures with a size of $\sim 10'' \times 50''$ ($0.02 \times 0.1$ pc). The CO emission at the most extreme blue and redshifted velocities (EHV) peaks $20''$ north of source I, just inside the rings of the HV bullets.

The low velocity $H_2O$ masers and the $H_2^*$ bullets around IRc2 are located at the inner edges of the ring of CO HV bullets and surrounding the EHV CO emission. Furthermore, the high velocity $H_2O$ masers are very well correlated with the EHV CO emission. This morphology is consistent with a model of a jet driven molecular outflow oriented close to the line of sight.

In the Orion–S outflow, the morphology of the CO HV bullets shows a bipolar structure in the southeast↔northwest direction, and the $H_2O$ masers are found only at low velocities in the region between the exciting source and the CO HV bullets.

The morphology of the CO HV bullets, the radial velocities and the spatial distribution of the $H_2O$ masers in both outflows, as well as the $H_2^*$ features around IRc2, are consistent with a model in which these outflows are driven by a jet variable in direction. In this scenario, the large traverse velocity measured for the $H_2O$ masers in the IRc2 outflow, $\sim 18\,\mathrm{km\,s^{-1}}$, supports the evolutionary connection between the jet and the shell-like outflows.

*Astronomy & Astrophysics Letters* , in press; *preprint requests:* arturo@oan.es *or on the Web:* http://www.oan.es/preprints/lista.html

## Bipolar Molecular Outflows

Rafael Bachiller and Mario Tafalla(1)
(1) Observatorio Astronómico Nacional (IGN), Campus Universitario, Apdo. 1143, E-28800, Alcalá de Henares, Spain

*Abstract*: Molecular outflows have been known to exist for about 20 years, and during these two decades they have been the subject of a very intense research effort. Outflows seem to play a major role in all the stages of star formation, from providing a mechanism for angular momentum loss to allow the assembling of the protostar, to stopping gravitational collapse and fixing the central object mass, and to dispersing the star-forming dense core and revealing the newly born star. In this chapter, we review the current knowledge on bipolar molecular outflows, with emphasis on those from low-mass young stars and protostars. We compare the properties of the poorly collimated outflows (which we refer as "classical") with those of a recently identified population of highly collimated flows. We propose that the observed differences are due to outflow evolution, and discuss how outflows evolve with time. We also review the extraordinary chemical anomalies found in some extremely young outflows, and the current models of outflow acceleration. We attempt to review not just those properties well understood, but point out future directions on outflow research.

To appear in *The Physics of Star Formation and Early Stellar Evolution* ed. C.J. Lada, (Kluwer, Dordrecht). Preprints available at:
http://www.oan.es/preprints/lista.html

## A Molecular Counterpart to the HH 1-2 Optical System

Amaya Moro-Martín(1), & José Cernicharo(1), Alberto Noriega-Crespo(2), Jesús Martín-Pintado(3)
(1)Instituto de Estructura de la Materia, Dpto. de Fisica Molecular, CSIC, Serrano 121, E-28006 Madrid, Spain
(2)Infrared Processing and Analysis Center, CalTech-JPL, Pasadena, CA 91125, USA
(3)Observatorio Astronómico Nacional. Apartado 1143, E-28800 Alcalá de Henares. Spain

*Abstract*: We present high angular resolution and sensitivity $^{12}$CO and $^{13}$CO $J$ = 2-1 and $J$ = 1-0 observations of the HH 1-2 outflow taken with then 30-m IRAM radio telescope. The observations show the bipolar molecular counterpart of the optical system driven by the VLA 1 embedded source moving with a velocity of $\simeq$ 30 km s$^{-1}$. Along the optical jet there are certain regions where the molecular gas reaches deprojected velocities of 100 km s$^{-1}$, and that we interpret as the molecular $^{12}$CO jet. The bipolar CO outflow has a length of $\sim$ 260$''$ and a curved morphology towards the North where it extends further away than the HH1 object ($\simeq$ 120 $''$) .

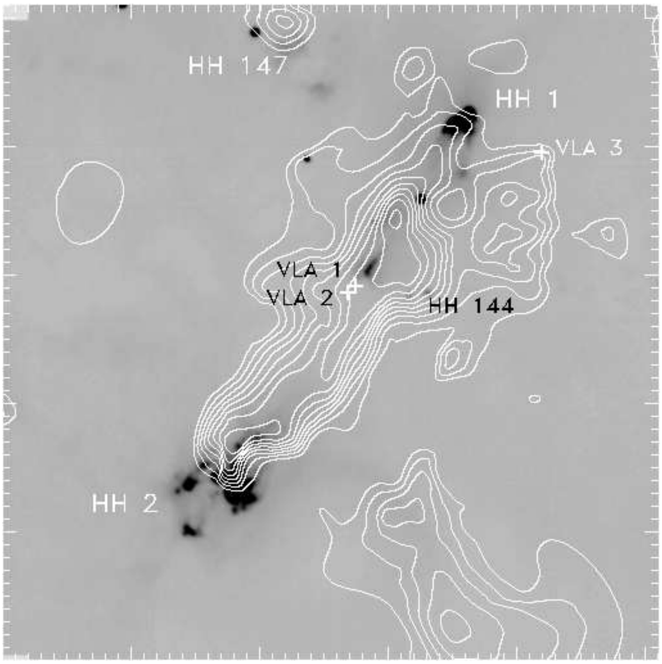



Figure 2:

Two new molecular outflows have been detected, one arising from IRAS 05339-0647 which excites the HH 147 optical flow and another powered by VLA 2 which drives the HH 144 optical outflow. The molecular outflow driven by the VLA 3 source is also clearly detected and spatially resolved from the VLA 1 main outflow.

*Astrophysical Journal Letters* in press. *Preprints available: cerni@astro.iem.csic.es*

## GG Tau: the Ring World

S.Guilloteau(1) A.Dutrey(1) M.Simon(2)
(1) Institut de Radio Astronomie Millimétrique, 300 Rue de la Piscine, F-38406 Saint Martin d'Hères, France
(2) Dept. of Physics and Astronomy, State Univ. of New York, Stony Brook NY 11794-3800, USA

*Abstract*: We present sub-arcsecond images of the mm dust emission and $^{13}$CO J=2–1 line emission in the young quadruple system GG Tau (see cover picture). These observations unambiguously resolve the circumbinary disk of the close ($\sim$ 0.3$''$) binary system into two distinct components: an extremely dense, sharp-edged ring, surrounded by an extended disk. Continuum emission is also detected from the center of this structure; it probably arises in the small circumstellar disk or disks of the binary. The kinematic data show that the ring+disk system is in Keplerian rotation and yield the estimate $M$ = (1.28 $\pm$ 0.07)($D$/140 pc)M$_\odot$ for the mass of the binary stars. We derive the physical parameters of the ring and disk from these data and from new 2$''$ resolution

images of the $HCO^+$ J=1–0 line and 3.4 mm continuum emission. The temperature in the ring plus disk system is consistent with heating by the stellar light (including the IR excess coming from the inner disks). Comparison with the optical/NIR images indicates a disk thickness compatible with an hydrostatic equilibrium.

*Astronomy & Astrophysics* in press; preprints: guillotte@iram.f

## Los Planetas recogen todos sus singles en un disco doble

Planets gather all their singles in a double disk

*Abstract*: Los planetas han echado la vista atras a 7 años de carrera y han recogido en una especie de album de memorias 33 temas publicados hasta ahora sólo en *singles y epés*. Segun Florent Muñoz del grupo granadino, el disco doble se titula *Compositiones para una orchestra quimica*.

*El Pais*, May 4, 1999, Espectaculos.

## Interferometric observations of nearby galaxies

N. Neininger(1)
(1) Radioastronomisches Institut der Universtät Bonn, Auf dem Hügel 71, D-53121 Bonn, Germany

*Abstract*: The IRAM Plateau de Bure interferometer is presently the most sensitive telescope in the range of 80–250 GHz. For the study of nearby galaxies, the field of view can be enlarged and the medium-small spacings recovered with the help of mosaicking techniques. This is particularly useful for the study of narrow spiral arms and edge-on galaxies.

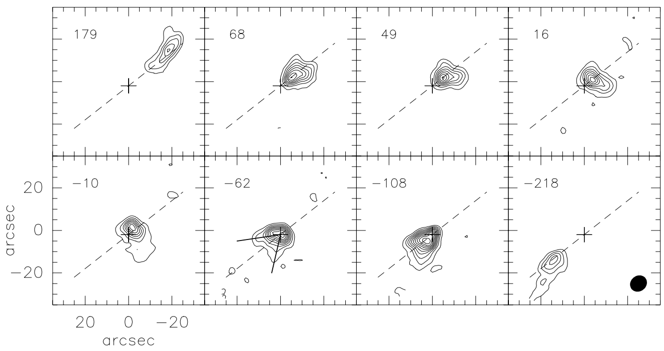



Figure 3: Selected velocity channel maps of the $^{12}CO$(1-0) emission in NGC 2146. The level step is 60 mJy/beam and the systemic velocity is subtracted. The cross marks the center of the galaxy. The traces of an outflow are clearly visible at all but the extreme velocity-channels.

### NGC 2146

NGC 2146, the "dusty hand" galaxy features a system of three dust lanes (spiral arms?) and clear signs of a starburst. It is seen with a large inclination angle. In contrast to other galaxies with strong star formation activity like M 82 or NGC 3628, no companion is visible that could have triggered the activity and there is no obvious sign of a present close encounter or merger. It is generally believed that the starburst was triggered by a merger which took place long ago and has disturbed the dynamics of the interstellar gas. The aim of our study was to search for traces of such a disturbance.

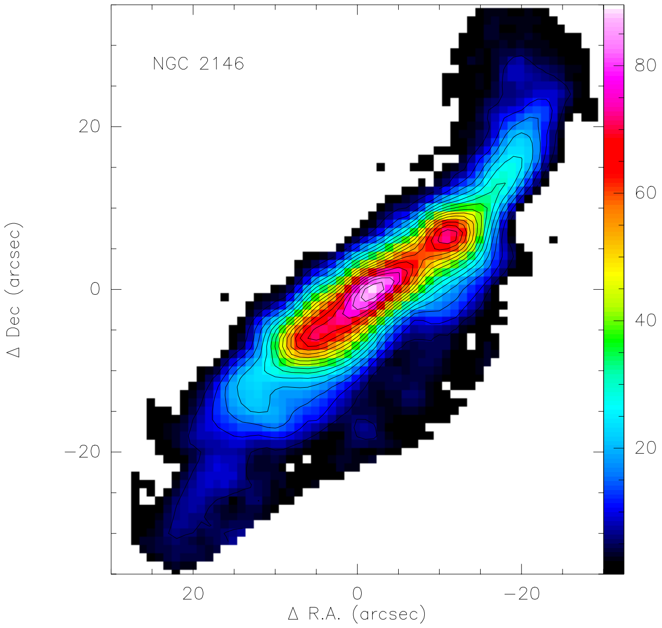



Figure 4: The integrated intensity of the $^{12}CO$(1–0) emission of NGC 2146, the steps are 5 Jy/beam·km $s^{-1}$. It peaks towards the central region, where also the strongest radio point sources are found. Note also the warp already prominent at this small scale.

We *(N. Neininger, A. Greve, A. Tarchi)* mapped NGC 2146's central 4 kpc region with the IRAM interferometer in the $^{12}CO$ (1-0), (2-1) and the $^{13}CO$(1-0) lines. Although the emission is found to be mostly concentrated towards the center, like in many spirals, a warp is clearly visible (Fig. 4, right part). We see outflowing molecular gas, but no evidence of gas linked to a merger or a companion galaxy (see Fig. 2).

Parallel to these observations of the molecular gas content, we have obtained high-resolution data at radio wavelengths ($\lambda$ 6 and 20 cm) with a combination of MERLIN and the VLA. We could identify a number of point sources which are currently under investigation (Tarchi et al., *in preparation*). The hope is to eventually compare their properties with their counterparts in M 82.

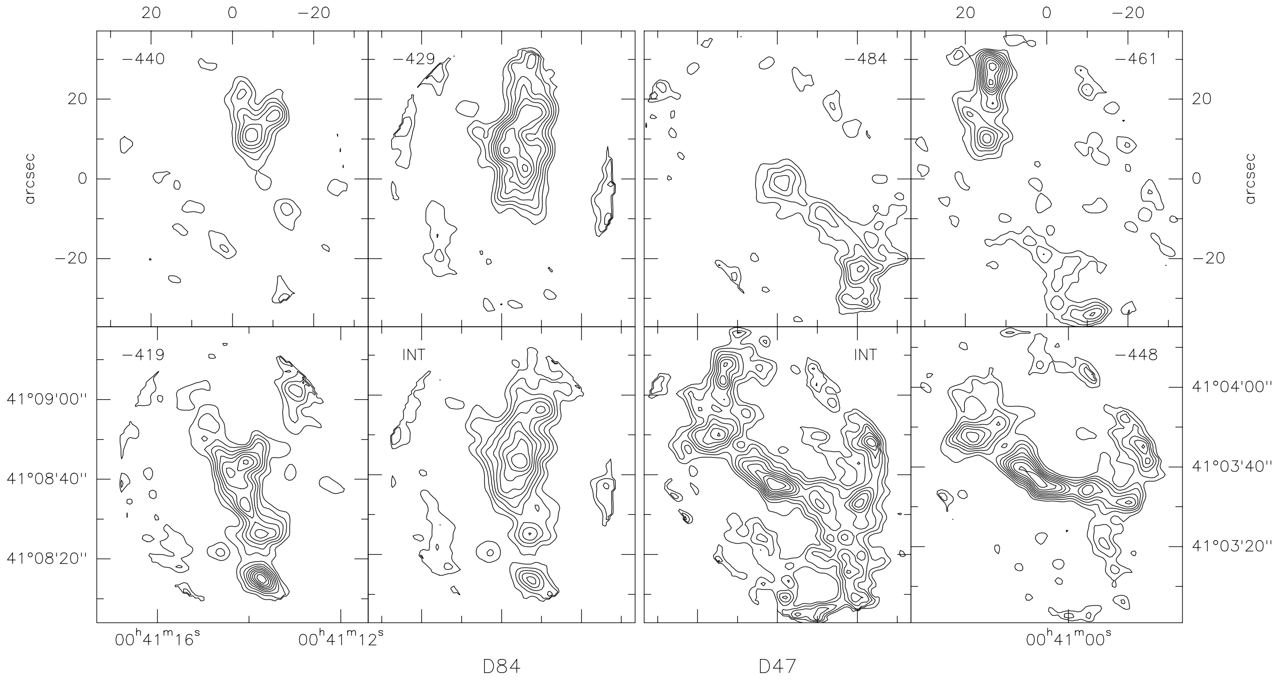



Figure 5: Maps of two prominent neaby cloud complexes of M 31: D 84 (left) and D 47 (right). The panels marked with a number (units kms$^{-1}$) show the intensity distribution in 10 kms$^{-1}$-wide velocity channels centred at selected velocities; the panels marked 'INT' display the velocity-integrated intensity. Contours are spaced in 10% steps of the peak which is $\sim 1$ Jy/beam for the channel maps, 2.5 Jy/beam for the integrated map of D84, and 1.6 Jy/beam for that of D 47. Note the filamentary shape and multi-component structure of cloud complex D 47.

**M 31**

The molecular gas in the southern half of M 31 is mostly concentrated in bright cloud associations distributed along in 3 narrow spiral arms of radius $\sim 6$, 11 and 18 kpc (Neininger et al. 1998). Figure 5 shows two such complexes observed at a resolution of $\simeq 2''$ (10 pc) with the IRAM interferometer. The molecular complex D 84 lies in a quiescent part of the 11 kpc arm, while D 47 is located 1.5 kpc farther to the SW, at the edge of one of the brightest HII regions of M 31. CO emission in D 84 mostly arises from a compact, 50-pc diameter source with a narrow velocity span (20 kms$^{-1}$); D 47 shows a complex filamentary structure with multiple velocity components. The spectra at the border of the bright HII region show two velocity components of similar intensities, spaced by 40 km$^{-1}$: emission is visible at positions (0,0) and (-20,-20) at -448 kms$^{-1}$ and -484 kms$^{-1}$ (LSR), but not at -461 kms$^{-1}$.

Such two-component spectra would be difficult to interpret in the Milky Way, where they would be attributed to two components at very different places along the line of sight. Here, it is clear from the location and the separation of the spiral arms that both belong to one single cloud complex. But wherefrom originate such big differences between those relatively close neighbours? The answer lies probably in the proximity of D 47 to the bright and extended HII region. Similarly broad spectra are found in the big southern dark cloud D 39 which also hosts a bright HII region and several star clusters. These are only few examples, but they point all into the same direction: broad or multiple-component spectra are most likely caused by local effects. These cloud complexes are certainly not virialized on the scale of 100 pc, the resolution of the 30-m telescope at the distance of M 31. The determination of the gas mass on the basis of data from the two instruments yields grossly differing values. To further investigate the properties of the molecular cloud complexes in M 31, we (*N. Neininger, M. Guélin, R. Lucas et al.*) are enlarging our sample of combined studies with the two IRAM instruments while pushing the angular resolution well below the 10 pc limit with the PdBI.


Hodge P.W., 1981, *Atlas of the Andromeda Galaxy* University of Washington Press

Neininger N., Guélin M., Ungerechts H., Lucas R., Wielebinski, R., 1998a, "Carbon Monoxide Emission as a Precise Tracer of Molecular Gas in the Andromeda Galaxy" *Nature* 395, 871–873

*Proceedings of the 3rd Cologne-Zermatt Symposium* in press; preprints: nneini@astro.uni-bonn.de

## Evidence for an Expanding Molecular Superbubble in M 82

A. Weiß, F. Walter, N. Neininger and U. Klein([1])
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*Abstract*: We present evidence for an expanding superbubble in M 82 (diameter: $\sim$ 130 pc, expansion velocity: $\sim$ 45 kms$^{-1}$, mass $\sim 8 \cdot 10^6$ M$_\odot$) as traced by $^{12}$CO(1-0), $^{12}$CO(2-1), $^{13}$CO(1-0) and C$^{18}$O(1-0) observations. The superbubble is centred around the most powerful supernova remnant 41.9+58 in M 82. The CO observations show that the molecular superbubble already broke out of M 82's disk. This scenario is supported by ROSAT HRI observations which suggest that hot coronal gas originating from inside the shell is the main contributor to the diffuse X-ray outflow in M 82. We briefly discuss observations of the same region at other wavelengths (radio continuum, optical, HI, X-rays, ionized gas). From our spectral line observations, we derive a kinematic age of about $10^6$ years for the superbubble. Using simple theoretical models, the total energy needed for the creation of this superbubble is of order $2 \times 10^{54}$ ergs (energy equivalent of 100 'regular' type II supernova (SN) explosions and the strong stellar winds of their progenitors). The average energy input rate (0.001 SN yr$^{-1}$) is reasonable given the high SN rate of $\sim$ 0.1 SN yr$^{-1}$ in the central part of M 82. As much as 10% of the energy needed to create the superbubble is still present in form of the kinematic energy of the expanding molecular shell. This newly detected expanding molecular superbubble is believed to be powered by the same objects which also lie at the origin of the prominent X-ray outflow in M 82. It can therefore be used as an alternative tool to investigate the physical properties of these sources.

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## Intergalactic cold dust in the NGC 4631 group

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*Abstract*: For the first time, we have detected extraplanar cold dust at distances out to more than 10 kpc, situated in the halo of the interacting galaxy NGC 4631. The dust emission disk is much thinner than the warped HI disk and new structures emerge. In particular, a giant arc has been found that is linked to anomalies in the kinematical structure of the atomic gas. Most of the extraplanar dust is closely associated with HI spurs that have been found earlier. These spurs obviously are traces of the interaction. The dust emission within the plane reaches the border of the optical disk.

The activity of the disk of NGC 4631 is moderately enhanced by the interaction, but no gas moving in the $z$-direction could be found. Hence it seems unlikely that strong winds have deposited the high-$z$ dust. Instead, the coincidence with the HI features suggests that we see a track left behind by the interaction. In addition, the HI shows a supershell formed by an impact in the zone where the dust trail crosses the disk. This region is also characterized by disturbances in the distribution of the H$\alpha$ light. The masses associated with the dust can be estimated only very roughly on the basis of the existing data; they are of the order of a few $10^9$ M$_\odot$ of gas.

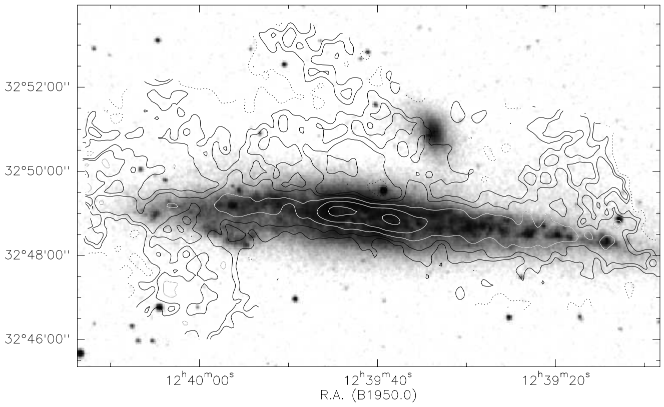


Figure 6: Map of the $\lambda$ 1.2 mm emission of NGC 4631, overlaid on an image taken from the Digital Sky Survey. The levels are -6 (dotted), 6, 11, 21, 41, 81 mJy/beam. Only significant emission is shown and the outer parts of the map with higher noise have been cut off. The small object north of the disk is the dwarf elliptical galaxy NGC 4627; the other companion, NGC 4656, is situated about half a degree away in the south-east.

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## Extended warm CO gas in three nearby galaxies

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*Abstract*:

We report the detection of distributed CO(3–2) line emission in nearby normal galaxies. The CO gas is a well-known tracer of physical conditions in the emitting regions. The line transitions from higher energy levels (the J=3 level is 33 K above ground) are indicators of the presence of warm and dense gas. Until now this warm gas has been studied only in the nuclei of starburst galaxies. Using the Heinrich-Hertz-Telescope on Mt. Graham

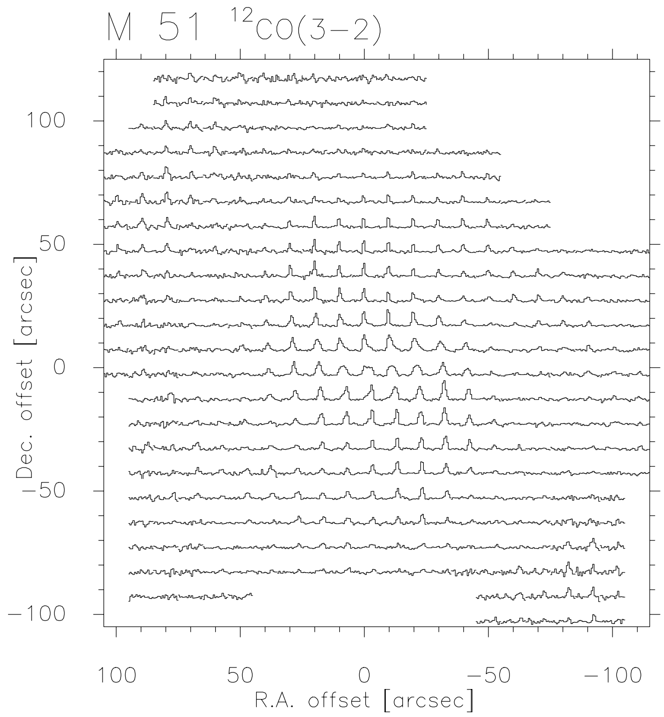


Figure 7: CO(3–2) spectra in M 51, with positions relative to the central coordinates R.A.[1950] = $13^{h}27^{m}46\overset{s}{.}1$, Dec.[1950] = $47°27'14''$. The scale of the individual spectra is $v_{\rm lsr} = 250 - 590$ km/s, $T_{\rm mb} = -0.2 - 0.8$ K.

we were able to detect extended CO(3–2) line emission in more than ten normal galaxies. In a first paper we present the results for the three galaxies M 51 (Fig. 7), NGC 278 and NGC 4631. In particular, we compare our results with observations of the lower CO line transitions made with radio telescopes of similar angular resolution.

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## Dust and CO lines in high redshift quasars

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*Abstract*: We report the results of a systematic search for redshifted rotational lines of CO and dust emission towards a sample of 9 high redshift radio quiet quasars using the IRAM Plateau de Bure interferometer. Dust emission at ∼ 1.35 mm has been found in 5 out of the 9 objects. These results confirm the corresponding previous detections with the MPIfR bolometer at the 30-m. No 3 mm continuum was detected in any source. The flux densities measured at 1.35 mm with the interferometer are systematically smaller by ∼ 30% from the broad-band bolometer fluxes, consistent with an average spectral index of ∼ 3.5 within the calibration uncertainty.

In parallel, searches for CO in significant redshift ranges were performed for 8 of the above sources. 6 sources were not detected. Assuming a line width of $\leq 450$ km.s$^{-1}$, we obtain typical upper limits of $\sim 0.4 - 0.5$ Jy km.s$^{-1}$ at the $3\sigma$ level in the frequency (redshift) range searched. We report a tentative ($3\sigma$) detection of the J=3-2 line of CO in Q 1230+1627B, and a unambigous detection of the J=5-4 CO line in the gravitationally lensed radio quiet quasar BRI 0952−0115 at a redshift of $z = 4.43$. After BR 1202−0725 at $z = 4.69$ (Otha et al. 1996, Omont et al. 1996a), and BRI 1335−0417 at $z = 4.41$ (Guilloteau et al. 1997), this is the third detection of CO at $z > 4$. The velocity-integrated CO(J=5–4) line flux is $0.91 \pm 0.11$ Jy km s$^{-1}$, with a linewidth of $230 \pm 30$ km s$^{-1}$. The 1.35 mm (250 $\mu$m rest wavelength) dust continuum flux density is 2.23±0.51 mJy, in agreement with previous measurements at 1.25 mm at the 30-m IRAM telescope. The ratio of the CO to 1.35 mm continuum flux is comparable to that of BRI 1335−0417 and 2-3 times larger than for BR 1202−0725. The angular resolution of the observation is not high enough to give evidence of any extension of the 1.35 mm continuum and 3 mm CO emission.

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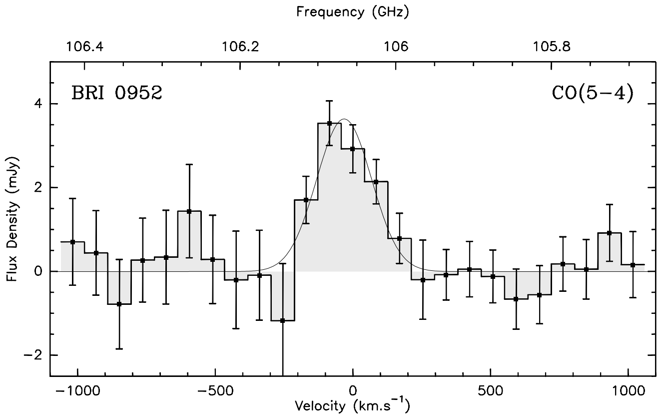


Figure 8: The CO(J=5–4) line observed in the radio quiet quasar BRI 0952−0115 with the IRAM interferometer

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