IRAM

Institut de Radioastronomie Millimétrique
Institut für Radioastronomie im Millimeterbereich
Instituto de Radioastronomía Milimétrica

Newsletter

Number 61 December 16th , 2004

Contents

Calendar

20-21 January 2005:
Radionet Synergy Meeting in Granada, Spain

1st February 2005:
Deadline for the submission of global VLBI proposals.

Interferometry school

From November 22 to 26, IRAM received the participants of its fourth mm interferometry school. A total of 55 researchers, working in ten different countries mostly as PhD students or postdoctoral associates, came to the Grenoble headquarters and attended 21 lectures, given both by invited speakers and IRAM staff members. The lectures are already available on the IRAM web pages (http://www.iram.fr/IRAMFR/IS/presentations.html).

Tutorials helped the students to become familiar with the calibration and imaging of mm interferometer data from the Plateau de Bure observatory. Thanks to guided tours of the IRAM laboratories, they received an impression of the technical work done in Grenoble.

Four young radio astronomers, some of them attendees of one of the previous mm interferometry schools, presented their projects at the Plateau de Bure interferometer, reaching from solar system science to gravitational lenses. 16 participants showed posters on their work at the cutting edge of modern astronomy.

We hope that the school will encourage the school's participants to use mm-wave interferometry for their scientific projects.

The mm interferometry school in Grenoble and the mm observing school organized by IRAM Granada, are an ongoing effort to offer hands-on courses to prepare both young and established scientists to use the IRAM telescopes, and to form an active community of future ALMA users.

Helmut Wiesemeyer

Staff Changes

IRAM Grenoble

The astronomer's group welcomes Pierre HILY-BLANT, who has started work on November 8th. His interests include dense cores and observations with multibeam receivers.

On November 16th, Beatrice MAIRE has started work at the IRAM reception.

Michael Bremer

News from the 30m Telescope

Travel to the 30-m telescope

If on your visit to our observatory you have lost or forgotten your toothbrush, shampoo or other hygiene articles, do not hesitate to ask our kitchen staff who have a small supply to help out in such kind of emergencies.

Starting February 5, 2005 Granada airport will have its first international flight connection: Ryan Air (www.ryanair.com) will offer a daily low price direct connection between Granada and London Stansted.

Rainer Mauersberger

Errors in the frequency calculations for the wideband single pixel receivers at Pico Veleta

The A230 and B230 receivers (in use since 1998 at Pico Veleta Observatory) and the C150, D150, C270 and D270 receivers (installed in 1999) and also HERA can be used for instantaneous bandwidths of up to 1 GHz. Since the use of the maximum instantaneous bandwidth of 1 GHz is incompatible with certain backend combinations, there is also a so called "narrowband mode" with 500 MHz instantaneous bandwidths for any of the above mentioned receivers. In the OBS control software, this narrow band mode is in fact the default.

Both modes require different settings of the IFs, and therefore different methods to calculate the sky frequency. It turned out that there has been an error in the calculation of the sky frequency of the above mentioned receivers *when used in narrowband mode.* This error was present from the installation of these receivers until recently, when the problem was detected and fixed (October 21th, 2004).

The calculational error concerns the Doppler correction. The error is thus small when the Earth moves perpendicular to the viewing direction and largest (i.e. 25 kHz for a source close to the ecliptic) 3 months later. The Doppler correction due to the rotation of the Earth is two order of magnitude smaller, and can therefore be neglected in almost any conceivable case. In the worst case, a CS(3-2) line could appear to move by 0.1 km/s between two observations performed 6 months apart. We are aware that this error is not negligible for some kinds of projects and apologize for the inconvenience this may cause. We are willing to offer our help to recover the correct frequencies and ask anybody whose data is affected to send me (mauers@iram.es) the corresponding project number, dates of observations and range of scan numbers and receivers used.

Rainer Mauersberger

Table 1: The confusion limit reached by the IRAM 30-m telescope toward some molecular line sources

Source Δv	λ mm	weakest detect. Lines mK	$t_{\rm int}^{a)}$ h	Ref.^{b}
IRC+10216	3	1.5	28	1)
$28\,{\rm km\,s^{-1}}$	2	3.5	10	1, 2)
	1.3	$\lesssim 2$	80	2)
Orion-KL	3	20	0.8	3)
$5\,{\rm km\,s^{-1}}$	2	50	0.3	4)
	1.3	70	0.4	3)
SgrB2(N)	3	~ 20	0.4	3)
$\sim 17\,{\rm km\,s^{-1}}$	2	~ 30	0.4	3)
	1.3	~ 40	0.5	3)

a) integration time (on+off) with present receivers at the IRAM 30-m telescope under normal winter conditions (good summer conditions), one polarization to obtain an rms of 1/3 $T_{\rm mb}$ with a velocity resolution of 1/5 the line width (one polarization receiver only); b)References: 1) Mauersberger, 2004, A&A **426**, 219 2) Ziurys et al. 2002, ApJ **564**, L45; 3) unpublished data; 4) Mauersberger et al. 1988, A&A **205**, 235; c) weaker lines can be identified if one makes use of the unique line shapes of the spectra of this source (Cernicharo et al. 2004, ApJ **615**, L145).

The confusion limit toward some astronomical molecular line sources

The following discussion is based on Mauersberger et al. (2004, A&A **426**, 219). From their Section 5.1 it is evident that in the 2 and 3 mm spectra of IRC+10216 presented in the article they are close to the confusion limit, where an increase of integration time does not yield much further information. It is interesting to investigate where line confusion begins to play a role for other favorite objects of molecule hunters such as the Orion Hot Core, Sgr B2. We limit our discussion to the IRAM-30m telescope. For an extrapolation of our results to other telescopes with a higher or lower resolution it is necessary to take into account the detailed source structure and chemical and physical conditions within the regions observed (Comito & Schilke 2002 A&A **395**, 357).

The definition of the useful observing time or rms to be reached is by no means unique and depends on whether one is interested in a mere detection of a line or whether one also wants to obtain some detailed information on the line shape. Here we try to be pragmatic: we have investigated spectra of several molecular line sources made with the IRAM 30-m telescope at 3 mm, 2 mm and 1.3 mm wavelength made with such a long integration that $\gtrsim 50\%$ of the spectral range observed is covered with features. We have determined the antenna temperature of the weakest unequivocal line features (knowing the typical line width and shape in the sources studied, but without sophisticated excitation analyses). The results are given in Table 1.

We also give an indication of the necessary rms for a $3\,\sigma$ detection with a velocity resolution pf 1/5 of the full line widths typical for these sources, and the corresponding necessary integration time with the 30-m telescope and its present receivers (including all observing overheads, using one polarization only). In Orion, part of the confusion arises because of the large line widths observed in the outflow source. This can e.g. be prevented by observing at a carefully selected position offset from the outflow source (Combes et al. 1996, A&A **308**, 618).

It will in certain cases be possible to identify lines that are weaker than the limits in Tab. 1

- if one carefully selects regions of the spectra which are relatively free of blending lines,
- if one can estimate the strengths of known blenders by an excitation analysis,
- if one makes use of information on the line shape and
- if one can confirm any such detections by observing several lines of a certain molecule.

Any observing proposal where lines close to the detection limit are requested should address these difficulties.

Rainer Mauersberger

Bolometer mapping - rotated chopping secondary

We now offer a new bolometer mapping mode at the 30m telescope using the rotated chopping secondary. In this observing mode the scanning and the chopping direction can be rotated with respect to the azimuth direction.

For mapping using the chopping secondary it is highly desirable to scan sources along their smallest spatial extent. So far this requirement limited the LST range when a source could be optimally observed while scanning in azimuth direction only. For some sources this condition is never fulfilled.

The rotation of the chopping secondary and the scanning direction eliminates this limitation (see Fig. 1). Currently we offer a rotation of the chopping secondary in the range of $\pm 60°$. We hope to extend this range soon to $\pm 90°$. The known misalignment between the subreflector hyperboloid axis and the subreflector rotation axis is mainly corrected at the time when the subreflector is rotated. Nevertheless, it is still recommended to execute a pointing scan just after the rotation in order to correct any pending offset.

The rotation of the chopping/scanning direction with respect to azimuth implies that the two chopper phases scan through different air masses which may lead to baseline drifts. From our experience this effect can efficiently be removed in the data processing at a level of $\approx 1\,$mJy in good weather conditions (see Fig.1).

The reduction software MOPSIC offers powerful planning tools to optimize the mapping parameters including the rotated secondary (AEO in MOPSIC, Fig. 2).

Albrecht Sievers, Juan Peñalver, Axel Weiß and Robert Zylka

VLBI observations and Call for Proposals

October 2004 VLBI session

Both IRAM instruments were participating successfully in the Global October VLBI session, together with the stations of Effelsberg, Onsala, Metsahovi and the VLBA.

The Plateau de Bure was operating with the EFOS-1 maser (Fig. 3) which will return to the geodetic station of Wettzell in mid-2005. The previous maser has been repaired by J.-M. Torre at the OCA (Observatoire de la Cote d'Azur), and is ready to go up to the observatory.

Every VLBI session demands a joint effort of telescope operators, technicians, astronomers and schedulers, which extends well beyond the duration of the actual observations. The October 2004 session was unusual due to its length of nearly 6 days and several observing frequency changes, and the absence of breaks in the schedule. Technical tasks had to be anticipated and moved carefully to make room for several days of uninterrupted observations. Bure and Pico Veleta observatories were assisted by personnel from MPIfR Bonn. Many thanks to all those who have made these observations possible.

Michael Bremer

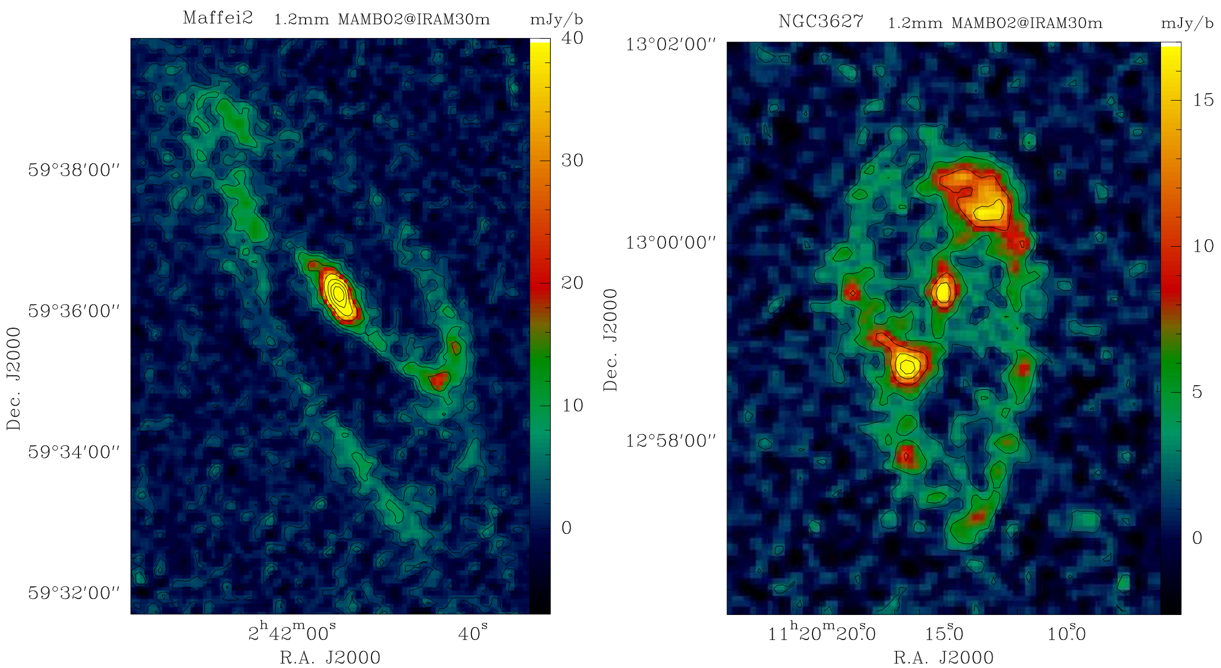

Figure 1: Maps of the 1.2mm dust continuum emission toward Maffei2 (left) and NGC3627 (right) obtained using MAMBO2 at the IRAM 30m telescope with a rotated chopping secondary. Each map contains several coverages with different rotation angles. The rms noise level is ≈ 1.5 mJy.

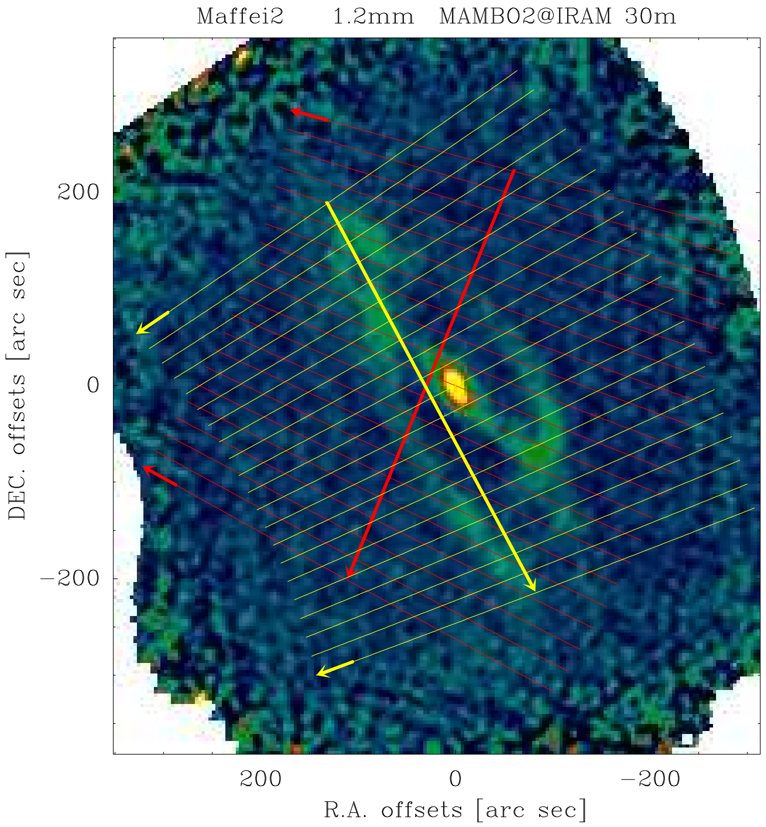

Figure 2: Schematic presentation of maps towards Maffei2 for a non rotated chopping secondary (red) and a rotation angle of 50° (yellow). The rotated map allows to scan perpendicular to the major axis of the galaxy.

Figure 3: The EFOS-1 maser in the PdBI correlator room. The maser itself is mounted on two stages of shock absorbers, which protect the frequency standard during its transport by road and helicopter. Its power supply can be seen in the background. To the right, the rack with the frequency synthesizers is installed, together with the computer which monitors the operating parameters of the maser.

Call for Global VLBI Proposals at 3mm wavelength

We announce the opportunity for coordinated, high angular resolution and high sensitivity GLOBAL VLBI observations in the 3mm band (85 - 95 GHz), complementing existing stand-alone VLBA observations at these frequencies. The Global 3mm VLBI Array consists of 8 VLBA antennas equipped with 3mm receivers, plus the IRAM 30-m telescope on Pico Veleta (Spain), the IRAM phased 6-element interferometer on Plateau de Bure (France), the 20-m radio telescope in Onsala (Sweden) the 14-m telescope in Metsähovi (Finland) and the MPIfR 100-m radio telescope in Effelsberg (Germany). Other telescopes may join later.

The Global 3mm VLBI Array is the successor to the former Coordinated Millimeter VLBI Array (CMVA) and offers 3 to 4 times more sensitivity than the stand-alone VLBA. Observations with the Global 3mm VLBI array will be scheduled in time blocks in special observing sessions, performed twice per year. The next two sessions are tentatively planned for April 15-20, 2005 and October 13-19, 2005. The actual duration of each session will depend on proposal pressure.

The Global 3mm VLBI Array basically supports the same observing modes as the VLBA. For standard continuum observations the VLBI recording will be done at 256 Mbit/s (corresponding to a bandwith of 128 MHz). Recording at 512 Mb/s is now offered as a standard mode for continuum observations in order to maximize the instantaneous sensitivity, but with the limitation of an equivalent data volume of not more than 2 tapes in 24hrs, to allow for those VLBA stations which still record exclusively on tapes.

Correlation will be performed in absentia at the MPIfR MK4 correlator in Bonn unless some technical reason for using another correlator is given in the proposal. The P.I. will receive the correlated data in uv-fits format.

Proposals for the October 2005 session should be prepared in a similar fashion as "normal cm-VLBI proposals", using the standard VLBI cover sheet and instructions available on the web under URL http://www.nrao.edu/administration/-directors_office/vlba-gvlbi.shtml and should be submitted electronically **as e-mail** before

<u>Tuesday, February 1st 2005, before 22:00 UT</u>
<u>(17:00 US Eastern Standard Time)</u>

to the following two addresses (<u>in copy</u>):

propsoc@nrao.edu
<u>and</u> propvlbi@mpifr-bonn.mpg.de

Proposals will be reviewed by NRAO and the participating European Observatories.

The European Schedule Coordinator, Dr. R. Porcas (MPIfR), will forward proposal copies to the participating European Institutes and ensure the scientific evaluation of the proposals by the respective local committees. Finally, the referee ratings of these observatories and the NRAO will be combined.

Global VLBI observations at 3mm are subject to some technical restrictions, which are summarized on the following web-page
(http://www.mpifr-bonn.mpg.de/div/vlbi/-globalmm/index.html).

The IRAM and MPIfR VLBI teams

Some useful web pages

VLBI observations allow unique insights in the astrophysics of compact and bright sources. Please prepare your proposals carefully, as they are equivalent to asking simultaneously for observing time on a large number of telescopes. Avoid last minute submissions: the e-mail submission may bounce large e-mails (critical limit about 5 Megabytes), returning them with details on how to submit via anonymous FTP. See http://www.nrao.edu/administration/-directors_office/vlba-gvlbi.shtml for more information.

- Technical details on VLBI observations: http://www.mpifr-bonn.mpg.de/div/vlbi/-globalmm/index.html
- Technical details on PdBI correlator in VLBI mode by Marc Torres: http://www.iram.fr-/IRAMFR/TA/backend/vlbi/index.html

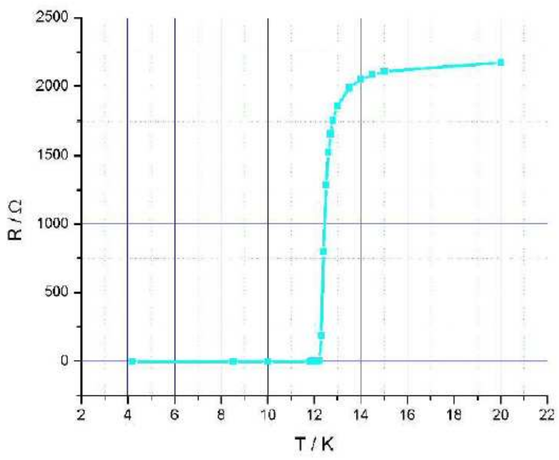

Figure 4:

– Very long baseline array observational status summary (J.M. Wrobel, April 5, 2002) http://www.aoc.nrao.edu/vlba/obstatus/obssum/-obssum.html
– CMVA Technical Information:
Array sensitivity: http://web.haystack.mit.edu/-cmva/tech_1.html
Field of view vs. Time averaging:
http://web.haystack.mit.edu/cmva/tech_2.html

Michael BREMER

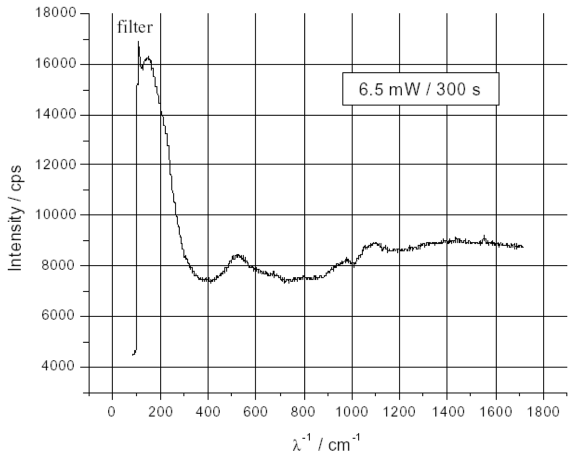

Figure 5:

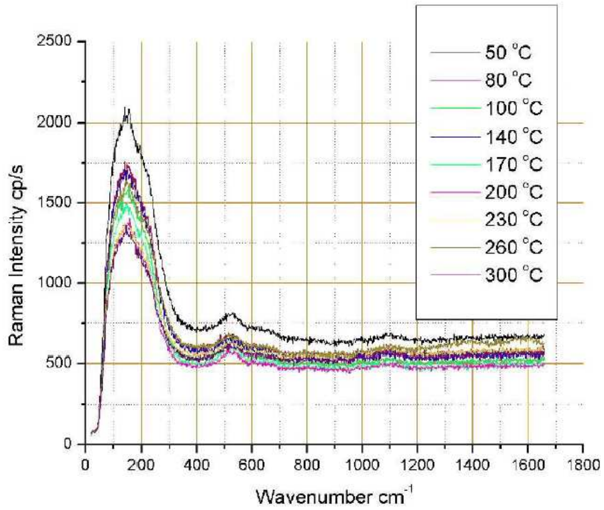

Figure 6:

IRAM Progress Report FP6 – RadioNet – AMSTAR (May-October 2004)

W.P. HEB-Mixer film fabrication and optimization

This work package concerns the development of phonon-cooled Hot Electron Bolometers (HEB) Mixers for observations above 1 THz (SOFIA) with the goal of fundamental study and optimization of ultrathin NbN film parameters.

The heterodyne detection of weak THz signals in radioastronomy with ultrathin superconducting microbridge bolometers necessitates optimized NbN film qualities to allow mixing with IF bandwidths up to 10 GHz. In this first step the following activities has been started:
– Production of 100 nm thick NbN films by RF sputtering of niobium in a nitrogen/methane/argon atmosphere to control the process parameters and the superconducting transport parameters of the deposited

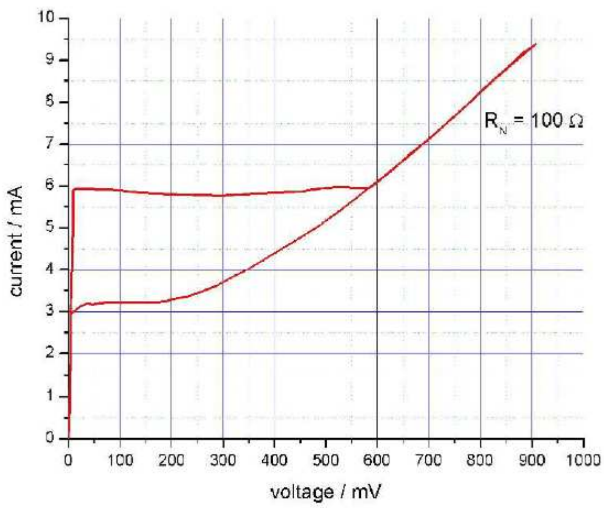

Figure 7:

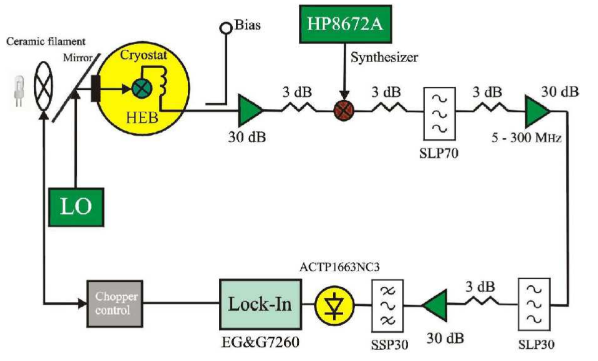

Figure 8:

films ($Tc \approx 15$ K, resistance ratio ≈ 0.96, specific resistance $\approx 130\ \mu\Omega$cm).

- Production of ultrathin (3 – 5 nm) NbN films on fused quartz with a 15 nm thick MgO seed layer ($T_c \approx$ 12 K).
- Determination of the optical constants of the deposited NbN films by means of ellipsometry (complex refractive index $\mathbf{n} = 1.89 - i \times 4.36$). The large value of the adsorption coefficient corresponds to a light penetration depth of about d = 5 nm. Therefore, Raman spectroscopy is a useful method to investigate very thin NbN films and their acoustic properties for the phonon cooling mechanism.
- Measurement of acoustic phonon density of states of thick and ultrathin (3 - 5 nm thick) NbN films by Raman spectroscopy. The measurements will help to derive the acoustic phonon matching for the realization of high IF bandwidths in the future HEB devices. A first result (phonon wavenumber ≈ 150 cm^{-1}) is shown in Figure 5.
- The evaluation of the crystalline film growth and the corresponding superconducting transport properties depending on the substrate temperature (range: room temperature to 700°C) during the deposition process will be carried out in the near future. Raman spectra for different deposition temperatures are already measured in the range of room temperature until 300°C (Fig. 6). In this low temperature range the spectra show similar behaviour. For higher temperatures a calibration procedure is necessary and will be done in the next fabrication step.
- The design and manufacturing of a 230 and 650 GHz photolithographic mask set for HEBs (3 chromium masks) with 0.5 and 1 micron bridge length for rapid IF bandwidth measurement up to 10 GHz is completed.
- Fabrication of a first batch on fused quartz / 15 nm MgO / 5nm NbN. The DC I/V-characteristics of the HEB test device is drawn in Figure 7.
- Preliminary mixer measurements at LO frequency of 230 GHz in the LHe-cryostat shows an IF bandwidth of about $\Delta f = 2$ GHz. The NbN film deposition temperature in this first test device was room temperature. We used the bandwidth measurement setup described in Fig. 8.

Publications

- T. A. Scherer, M. Frommberger, M. Schicke, K. Schuster, "Development of Phonon Cooled Hot-Electron-Bolometers (HEB) for Applications in THz Radioastronomy" , Proc. Of the 29th Int. Conf. On Infrared and Millimeter Waves, 12th Int. Conf. On Terahertz Electronics, Sept. 27 – Oct. 1 2004, Karlsruhe, Germany.
- T. A. Scherer, M. Frommberger, M. Schicke, K. Schuster, "Entwicklung Phonon-gekuehlter Hot-Electron-Bolometer (HEB) fuer Anwendungen in der THz-Radioastronomie" , Kryoelektronische Bauelemente 2004, Goslar, Germany, 12.– 14. Sept. 2004.

T. A. Scherer, K. Schuster, M. Schicke

Scientific Results in Press

Carbon budget and carbon chemistry in Photon Dominated Regions

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([1])Space Research Organization Netherlands, PO Box 800, 9700 AV Groningen, The Netherlands ([2])Laboratoire d'Étude du Rayonnement et de la Matière, UMR 8112, CNRS, École Normale Supérieure et Observatoire de Paris, 24 rue Lhomond, 75231 Paris Cedex 05, France, ([3])Institut de Radioastronomie Millimétrique, 300 rue de la Piscine, 38406 St Martin d'Hères, France, ([4])Institut d'Astrophysique Spatiale, Université Paris-Sud, Bât. 121, 91405 Orsay Cedex, France, ([5])LUTH, UMR8102 du CNRS, Observatoire de Paris, Place J. Janssen, 92195 Meudon Cedex, France

Abstract:
We present a study of small carbon chains and rings in Photon Dominated Regions (PDRs) performed at millimetre wavelengths. Our sample consists of the Horsehead nebula (B33), the ρ Oph L1688 cloud interface, and the cometary-shaped cloud IC 63. Using the IRAM 30-m telescope, the SEST and the Effelsberg 100-m telescope, we mapped the emission of C_2H, c-C_3H_2 and C_4H, and searched for heavy hydrocarbons such as c-C_3H, l-C_3H, l-C_3H_2, l-C_4H_2 and C_6H. The large scale maps show that small hydrocarbons are present until the edge of all PDRs, which is surprising as they are expected to be easily destroyed by UV radiation. Their spatial distribution

reasonably agrees with the aromatic emission mapped in mid-IR wavelength bands. C_2H and c-C_3H_2 correlate remarkably well, a trend already reported in the diffuse ISM (Lucas & Liszt 2000). Their abundances relative to H_2 are relatively high and comparable to the ones derived in dark clouds such as L134N or TMC-1, known as efficient carbon factories. The heavier species are however only detected in the Horsehead nebula at a position coincident with the aromatic emission peak around 7 μm. In particular, we report the first detection of C_6H in a PDR. We have run steady-state PDR models using several gas-phase chemical networks (UMIST95 and the New Standard Model) and conclude that both networks fail in reproducing the high abundances of some of these hydrocarbons by an order of magnitude. The high abundance of hydrocarbons in the PDR may suggest that the photo-erosion of UV-irradiated large carbonaceous compounds could efficiently feed the ISM with small carbon clusters or molecules. This new production mechanism of carbon chains and rings could overcome their destruction by the UV radiation field. Dedicated theoretical and laboratory measurements are required to understand and implement these additional chemical routes.

Appeared in: A&A 417, 135

High-spatial-resolution CN and CS observation of two regions of massive star formation

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Abstract:
Molecular line CN, CS and mm continuum observations of two intermediate- to high-mass star-forming regions – IRAS 20293+3952 and IRAS 19410+2336 – obtained with the Plateau de Bure Interferometer at high spatial resolution reveal interesting characteristics of the gas and dust emission. In spite of the expectation that the CN and CS morphology might closely follow the dense gas traced by the dust continuum, both molecules avoid the most central cores. Comparing the relative line strengths of various CN hyperfine components, this appears not to be an opacity effect but to be due to chemical and physical effects. The CN data also indicate enhanced emission toward the different molecular outflows in the region. Regarding CS, avoiding the central cores can be due to high optical depth, but the data also show that the CS emission is nearly always associated with the outflows of the region.

Therefore, neither CS nor CN appear well suited for dense gas and disk studies in these two sources, and we recommend the use of different molecules for future massive disk studies. An analysis of the 1 and 3 mm continuum fluxes toward IRAS 20293+3952 reveals that the dust opacity index β is lower than the canonical value of 2. Tentatively, we identify a decreasing gradient of β from the edge of the core to the core center. This could be due to increasing optical depth toward the core center and/or grain growth within the densest cores and potential central disks. We detect 3 mm continuum emission toward the collimated outflow emanating from IRAS 20293+3952. The spectral index of $\alpha \sim 0.8$ in this region is consistent with standard models for collimated ionized winds.

Accepted for publication in ApJ

The disrupted molecular envelope of Frosty Leo

A. Castro-Carrizo(1), V. Bujarrabal(2), C. Sanchez Contreras(3), R. Sahai(4), J. Alcolea(2)
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Abstract:
We present maps of CO emission in the protoplanetary nebula Frosty Leo. Observations of the rotational transitions ^{12}CO J=2-1 and 1-0 have been obtained with the IRAM interferometer and the OVRO array. The molecular envelope of Frosty Leo is found to be complex and compact; most of the gas extends $\lesssim 6''$ and shows a structure that is very different to the extended optical nebula. It is composed of a central ring-like structure, whose symmetry axis is inclined $\sim -40°$ with respect to the sky plane and expands at speeds of up to $\sim$ 30 km s^{-1}, and high-velocity jets distributed along the symmetry axis of the ring, which reach expansion velocities as high as $\sim$ 75 km s^{-1}. The symmetry axis of the molecular jets in the plane of the sky coincides with the direction of some jet−like features seen in the optical, which are not aligned at all with the main symmetry axis of the optical nebula. The brightness distribution of the ring presents a clumpy structure. We have modeled the spatio-kinematical distribution of, and the excitation conditions in, the molecular envelope. For both transitions, the ^{12}CO emission is found to be very optically thick in the center of the nebula. From our best-fit model, we find that the nebular particle density varies between $\sim 10^5$ cm^{-3} and $\sim 10^3$ cm^{-3}, and that the rotational temperature is very low, $\sim$ 10 K. The kinematical lifetime of the molecular jets is $\sim$ 1700 yr, long in comparison with the lifetime of the post-AGB winds of most PPNe. It is very remarkable that the bulk of the gas accelerated during the post-AGB phase of Frosty Leo

is located within the central ring, reaching expansion velocities of up to $\sim$ 30 km s^{-1}. The central ring-like distribution of Frosty Leo is probably not the undisrupted remnant of the previous AGB envelope (as found for most PPNe), but its dynamics likely result from multiple post-AGB interactions.

Accepted for publication in A&A

Deuterated Thioformaldehyde in the Barnard 1 Cloud

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Abstract:
We present observations of the singly and doubly deuterated species of thioformaldehyde, HDCS and D_2CS, towards the dark cloud Barnard 1. This is the first detection of D_2CS in Space and in dense and cold prestellar regions. Column densities obtained using rotational diagrams and a Large Velocity Gradient model show an extremely high D-enhancement in thioformaldehyde in Barnard 1. Although the column density of H_2CS is smaller than that of H_2CO, both species show similar D-enhancements in their singly and doubly deuterated species. A chemical model -including multiply deuterated species- has been used in order to interpret the observations.

Predicted rotational frequencies from laboratory data for HDCS and D_2CS are significantly in error when compared to the observed frequencies in Space. Consequently, we have derived new rotational constants for these two species and for H_2CS and $H_2C^{34}S$ using the observed frequencies in Barnard 1. The new rotational constants allow to predict the rotational transitions of these species with the accuracy needed for the narrow line emerging from dark clouds. Rotational constants for HDCS and D_2CS have been obtained from the observed transitions in the laboratory and in Space.

Based on observations carried out with the IRAM 30 m telescope. IRAM is supported by INSU/CNRS (France), MPG (Germany) and IGN (Spain).

Accepted for publication in ApJ

22 GHz tunable Bandpass Filters based on Niobium MEMS

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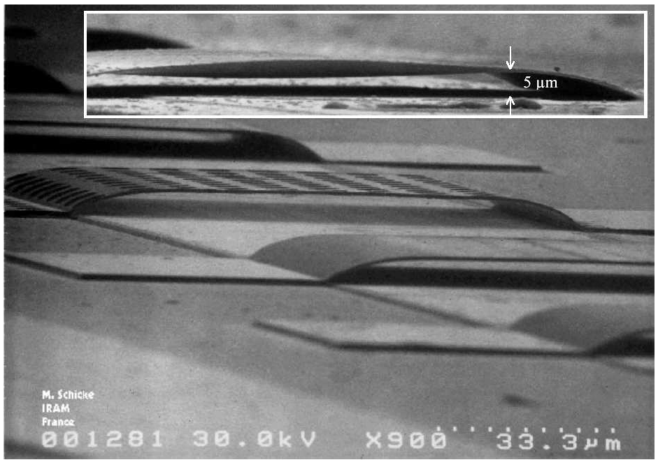

Figure 9: Nb air bridges, 5μm high, 100μm long and 100μm wide. The Nb film is 700 nm thick (240 nm in the inset). The inset shows the bending of the bridge layer and the reduced height due to stress in the Nb film.

France, (2)Radio Astronomy Lab, University of California, 601 Campbell Hall, Berkeley CA 94720-3411, USA

Abstract:
We present the design of two 22 GHz tunable bandpass filters based on variable capacitors (in Niobium MEMS technology) realized as short sections of superconductive lines with properties similar to microstrips. The air gap between the top electrode (the microbridge) and the bottom electrode of the thin film Niobium (Nb) microstrips can be varied by $\propto$ 30% through the electrostatic force generated by a DC bias voltage (Fig. 9). Electromagnetic simulation of the two filters predicts a tuning range of $\propto$ 11% and $\propto$ 14% of the central filter frequency. One goal of this development is to demonstrate the application of Nb microbridges for variable filters at 22 GHz in view of a transfer to several hundreds of GHz. All steps of the low temperature ($< 150°$C) fabrication procedure are compatible with the fabrication of Nb- Al/AlOx-Nb SIS tunnel diodes, used in heterodyne high frequency mixers operated at 4 K. This fabrication procedure sets limits to the dimensions of the microbridges.

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Sulfur chemistry and isotopic ratios in the starburst galaxy NGC 253

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Abstract:
Based on observations of the most abundant sulfur-bearing molecules (H_2S, CS, NS, SO, H_2CS, OCS, and SO_2) carried out with the IRAM 30m telescope and SEST, we present the first analysis of the sulfur chemistry of an extragalactic source, the nuclear region of the starburst galaxy NGC 253. This is the first time that H_2S and, tentatively, H_2CS are detected towards the nucleus of a starburst galaxy.

Source averaged fractional abundances of these molecules are a few 10^{-9}, except for CS and OCS which are more abundant (10^{-8}). Sulfur isotopic ratios, $^{32}S/^{34}S \sim 8 \pm 2$ and $^{34}S/^{33}S > 9$, are measured through observations of ^{13}CS, $C^{34}S$, and $C^{33}S$. A comparison with the observed relative abundances towards different prototypical Galactic sources suggests that the chemical composition of NGC 253 is similar to that found towards the molecular clouds complexes like Sgr B2 in the nuclear region of the Milky Way. The large overabundance of OCS compared to the predictions of time-dependent sulfur chemistry models supports the idea that OCS is likely injected into the gas phase from the grain mantles by low velocity shocks.

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The polarization of mm methanol masers

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Abstract:
We present a survey of the polarization properties of mm-wavelength methanol masers, comprising both classes, and transitions from 84.5 to 157.0 GHz. Linear polarization is found in more than half of the observed objects, and circular polarization is tentatively detected in two sources. Class I and Class II CH_3OH masers show similar polarization properties. The largest linear polarization is found in the 133 GHz Class I maser towards L 379 (39.5 %), and in the 157 GHz Class II maser towards G 9.62+0.19 (36.7 %). The spectral profiles of the polarization angle of Class I masers are mostly flat, except for two sources showing a linearslope. Since the mm-line methanol masers are expected to be weakly (or not) saturated, we suggest that the stronger fractional polarizations found by us are enhanced by anisotropic pumping and radiative losses. In NGC 7538, we find, for both maser classes, a good agreement between our polarization angles, and those measured for the submillimeter dust continuum. This can be taken as evidence for magnetic alignment of dust grains. It is also possible that an unsaturated maser with equally populated magnetic substates simply amplifies polarized continuum seed radiation. For Class II masers, the polarization properties of the various velocity components towards a given source with detectable polarization are quite homogeneous. A possible explanation is discussed. Since methanol is non-paramagnetic, the circular polarization of the unsaturated maser emission can only be due to variations of the angle between the magnetic field and the line of sight along the maser propagation path.

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Extending the radio spectrum of magnetic chemically peculiar stars to the mm range

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Abstract:
Magnetic chemically peculiar (MCP) stars can present radio emission at centimetre wavelengths. The steep decrement of the dominant dipolar component of the photospheric magnetic field results in each radio frequency being mainly emitted in a well localised shell of the circumstellar region. To explore the most internal regions of the magnetosphere, observations of a sample of eleven MCP stars known to be radio sources in the 1.4-22.5 GHz range were carried out at 87.7 GHz with the IRAM interferometer. Millimeter emission, with a flux density at about 4× the sensitivity limit of our observations, was detected towards two of the stars: HD 35298 and HD 124224. Combining our mm-observations with previous cm-observations, it appears that MCP stars with a relatively weak magnetic field present a radio spectrum that increases with frequency up to 22.5 GHz and then decreases towards the mm range. In presence of strong fields, the radio spectrum is always decreasing with frequency. A comparison of the observed cm-mm spectrum of HD 124224 with results of numerical simulations of the gyrosynchrotron emission suggests that circumstellar regions emitting in the mm-range cannot present magnetic fields larger than 1-2 kG.

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NEAR-ARCSECOND RESOLUTION OBSERVATIONS OF THE HOT CORINO OF THE SOLAR-TYPE PROTOSTAR IRAS 16293-2422

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Abstract:
Complex organic molecules have previously been discovered in solar-type protostars, raising the questions of where and how they form in the envelope. Possible formation mechanisms include grain mantle evaporation, the interaction of the outflow with its surroundings, and/or the impact of UV/X-rays inside the cavities. In this Letter we present the first interferometric observations of two complex molecules, CH_3CN and $HCOOCH_3$, toward the solar-type protostar IRAS 16293-2422. The images show that the emission originates from two compact regions centered on the two components of the binary system. We discuss how these results favor the grain mantle evaporation scenario, and we investigate the implications of these observations for the chemical composition and physical and dynamical state of the two components.

Appeared in: ApJ 617, L69

ATOMIC CARBON IN PSS 2322+1944, A QUASAR AT REDSHIFT 4.12

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Abstract:
We report the detection of the $^3P_1 \rightarrow {}^3P_0$ fine-structure line of neutral carbon in the z=4.12 quasar PSS 2322+1944, obtained at the IRAM Plateau de Bure interferometer. The [C II] $^3P_1 - {}^3P_0$ line is detected with a signal-to-noise ratio of $\propto$ 6 with a peak intensity of $\approx$ 2.5 mJy and a velocity-integrated line flux of 0.81 ± 0.12 Jy km s^{-1}. Assuming an excitation temperature of 43 K (equal to the dust temperature), we derive a mass of neutral carbon (corrected for magnification) of $M_{CI} \approx 1.2 \times 10^7 \mathrm{M}_\odot$. In PSS 2322+1944, the cooling due to C is about 6 times smaller than for CO, whereas the CO and C cooling represents $\approx 10^{-4}$ of the far-infrared continuum and more than half of the cooling due to C^+.

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