iram info

Number 76

March 2011

Word from the Director

Dear IRAM Newsletter Reader,

Since the last issue, the Plateau de Bure interferometer underwent major enhancements. The refurbishment of all antennas with aluminium panels was completed. The LO reference system was upgraded from DRO to YIG-based oscillators, improving significantly the phase noise. Finally, all the antennas were equipped with 345 GHz receivers that include electronically tunable 1st Local Oscillators and modified versions of the 2SB mixers developed for the ALMA Band 7, providing excellent noise performance and a 4 GHz IF bandwidth. First results obtained at these high frequencies are described in this Newsletter.

At the 30-meter telescope, new Fourier Transform spectrometers were installed at the end of 2010 and upgrades are planned for a 32 GHz instantaneous bandwidth. A spectacular development of a sideband-separating mixer for the EMIR Band 3 was achieved in the lab that will extend the frequency range (200-280 GHz) and double the continuum sensitivity.

Finally, we are pleased to announce that NOEMA has been granted 10 M€ by the French Ministry of Research, a success which will have a profound and positive impact on the future of IRAM.

Pierre Cox

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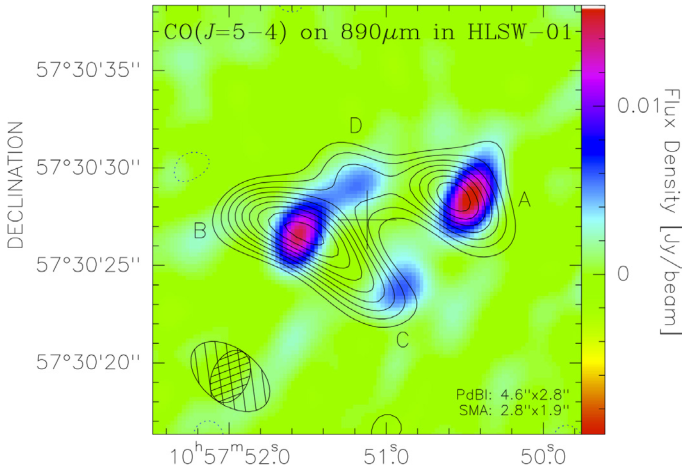
Studies of Herschel gravitational lenses

by Alain Omont and Pierre Cox



Map of the molecular gas in the 5-4 transition of CO (shown as contours) and the dust emission at 890 microns (color image) towards the lensed galaxy HLSW-01 at z=2.95. The line data were obtained using the Plateau de Bure interferometer and the dust continuum was measured with the SubMillimeter Array (SMA) in Hawaii.

The four spots of the lensed image are clearly seen with a maximum separation of ~9", revealing the internal gas dynamics in this system. From Riechers et al. (2011).

Gravitational lensed sources have played an important role in infrared and sub-millimetre studies of high-redshift galaxies and active galactic nuclei (AGN) since the discovery of FSC10214+4724 by the IRAS satellite (Rowan-Robinson et al. 1991). Similar sources (including the Cloverleaf) triggered the sub-millimetre studies of galaxies in the early universe and allowed pioneering detections of the properties of these systems through observations of the emission of the dust continuum and the molecular lines. In this new field, the IRAM facilities played a key role from the early 1990's onward. The results demonstrated the usefulness of strong gravitational magnification in the investigation of the detailed properties of distant galaxies.

This observational field has recently received a new boost from the results released from the wide-field surveys done with the Herschel Space Observatory – in particular, the H-ATLAS and HerMES projects that will cover 570 and 70 square-degrees, respectively (Eales et al. 2010; Oliver et al. 2010). These surveys have already increased the area of sub-millimetre surveys by factors of hundreds compared to the widest surveys that were previously available. One may expect that the number of strongly lensed sources will

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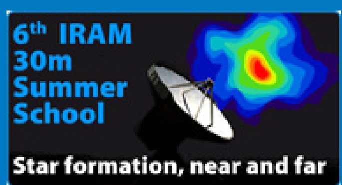

6th IRAM 30m Summer School

The 6th 30m summer school "Star formation, near and far" will take place in the week of September 23 to 30 this year, in the ski resort Pradollano.

Read more about the summer school on page 16.

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News from the Plateau de Bure Interferometer

by Jan Martin Winters

In November, Bure entered into the winter observing period with the array in its C-configuration and moved to a compact (D like) configuration on December 18, 2010 for the commissioning of band 4.

Science verification observations in band 4 were completed successfully at the beginning of 2011.

Aluminum panels for antennas 1 and 6

Following the reflector upgrades of antennas 4 (2008) and 2 (2009), the remaining two antennas 1 and 6 were equipped with aluminum panels in the summer and fall of 2010. Work on antenna 1 was finished on June 28, and antenna 6 followed on October 17. The surfaces of both antennas were subsequently adjusted to accuracies of better than 50 μm rms in a series of holographic measurements and panel adjustments. All six Bure antennas are now equipped with aluminum reflectors.

Band 4 receivers and 3rd generation LO system

Band 4 mixers, covering the frequency range from ~275 to ~373 GHz, have been installed last summer on the remaining 4 antennas (antennas 4 and 5 were already equipped in 2009). The new 0.8mm band was commissioned during the Christmas period and first science verification as well as regular user requested observations have been successfully obtained since the beginning of this year. The performance of the new band 4 receivers meets our highest expectations. The mixer for the vertical polarization on antenna 1 suffers however from a hardware problem and will therefore be replaced during the upcoming antenna maintenance period. Observations in the 0.8mm band are very demanding in terms of atmospheric transparency and stability and, therefore, are restricted to the best winter weather conditions.

A new (this is the 3rd generation) LO system was installed on Plateau de Bure during September, and is routinely used since the beginning of October.

Weather conditions and observing

The current winter semester so far was affected by variable weather conditions with periods of excellent atmospheric stability and transparency at the beginning of November and January as well as during the second half of January, but with very poor weather during most of December. Bure entered into the winter observing period with the array in the C-configuration going to a compact (D like) configuration on December 18 for the commissioning of band 4. Science verification observations in band 4 could be done at the beginning of the year. The Bure staff moved the array to the B configuration on January 5 in order to prepare for the long haul to the A configuration. Because of large amounts of snow on the tracks and of adverse weather conditions around mid of January, the move to this most extended configuration had to be delayed until January 18. The array was kept in the A configuration until mid

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February and moved back into the second most extended configuration B on February 10. We currently anticipate to go to the C configuration by beginning of March. The switch to the most compact D configuration is not foreseen before April. Global VLBI observations, which include the array in the 3mm phased-array mode, are scheduled from May 5 to 10, 2011. According to these plans, it will not be possible to complete projects requesting deep integrations using the compact configurations before the end of the semester.

As far as A-rated projects are concerned, we hope to bring most of these to completion before the end of the current winter semester. B-rated projects are likely to be observed only if they fall in a favorable LST range. We remind users of the Plateau de Bure interferometer that B-rated proposals which are not started before the end of the winter semester have to be resubmitted.

Investigators, who wish to check the status of their project may consult the interferometer schedule on the Web at http://www.iram.fr/IRAMFR/PDB/ongoing.html. This page is updated daily.

News from the 30m Telescope

by Carsten Kramer

Since December 2010, 8 fast Fourier Transform Spectrometers at 195kHz resolution are available at the 30m telescope for observations with EMIR.

Fourier Transform Spectrometers

Since December, 1st, 2010, 8 fast Fourier Transform Spectrometers (FTS) at 195kHz resolution are available for observations with EMIR. They are split into two blocks of 4GHz each which can be connected to the EMIR bands. Since then, the FTS have been successfully used with a variety of observing modes. Some first results including an on-the-fly map are presented in this newsletter.

The increase of backend channels puts much more load onto the online data processing (odp) system. We therefore recommend not to use the FTS when their high spectral resolution is not needed.

We are currently addressing two subtle problems related to the FTS: rarely, about once per day, calibration subscan IMBfits raw data files are not being written to disk. And, very narrow spurious signals or spikes show-up in the FTS, and other backends, at known frequencies in the IF band. We have started to split-up and speed-up the odp, now creating individual CLASS spectraOdp files per backend and per day.

This is also work done in preparation of the extension to 32GHz instantaneously available bandwidth with 24 FTS, which is planned for mid 2011.

Planned upgrade to 32GHz of instantaneous bandwidth

The new system can be used to observe simultaneously both polarisations of the 16GHz wide sidebands of the 3mm E090 band of EMIR. The number of IF cables between the receiver cabin and the backend room will be doubled, from 4 to 8, each cable transporting 4GHz of bandwidth. Three FTS units will be connected to each cable, to cover all 4GHz at 195kHz resolution, or, alternatively, the inner 1.8GHz at 50kHz resolution. It will be possible to connect 18 FTS units to the 18 channels of HERA. All 24 FTS units can either be set to 195kHz or to 50kHz resolution.

The four new IF cables are connected to the 4 outer bands of E090. The possibilities to combine bands and backends which were available so far with 4 IF cables, are unchanged. In particular, the possibilities to use VESPA, are unchanged.

Observers may consider to use the new capabilities of the FTS to conduct e.g. a 3mm frequency survey covering 32GHz with both polarisations at 195kHz resolution in two frequency setups shifted by 8GHz, i.e. by the frequency gap between inner lower and upper bands of EMIR E090.

The FTS units will increase the amount of spectral line channels to upto 300,000 channels, which is an order of magnitude more than offered so far with VESPA, 4MHz, and WILMA. Commissioning will ultimately show whether the sampling times of fast switching observing modes need to be restricted to accomodate this increase in the amount of data to be handled.

If installation and commissioning workout fine without problems, we plan to make this new system available early in the summer semester. The more precise numbers and possibilities will be advertised on the EMIR homepage.

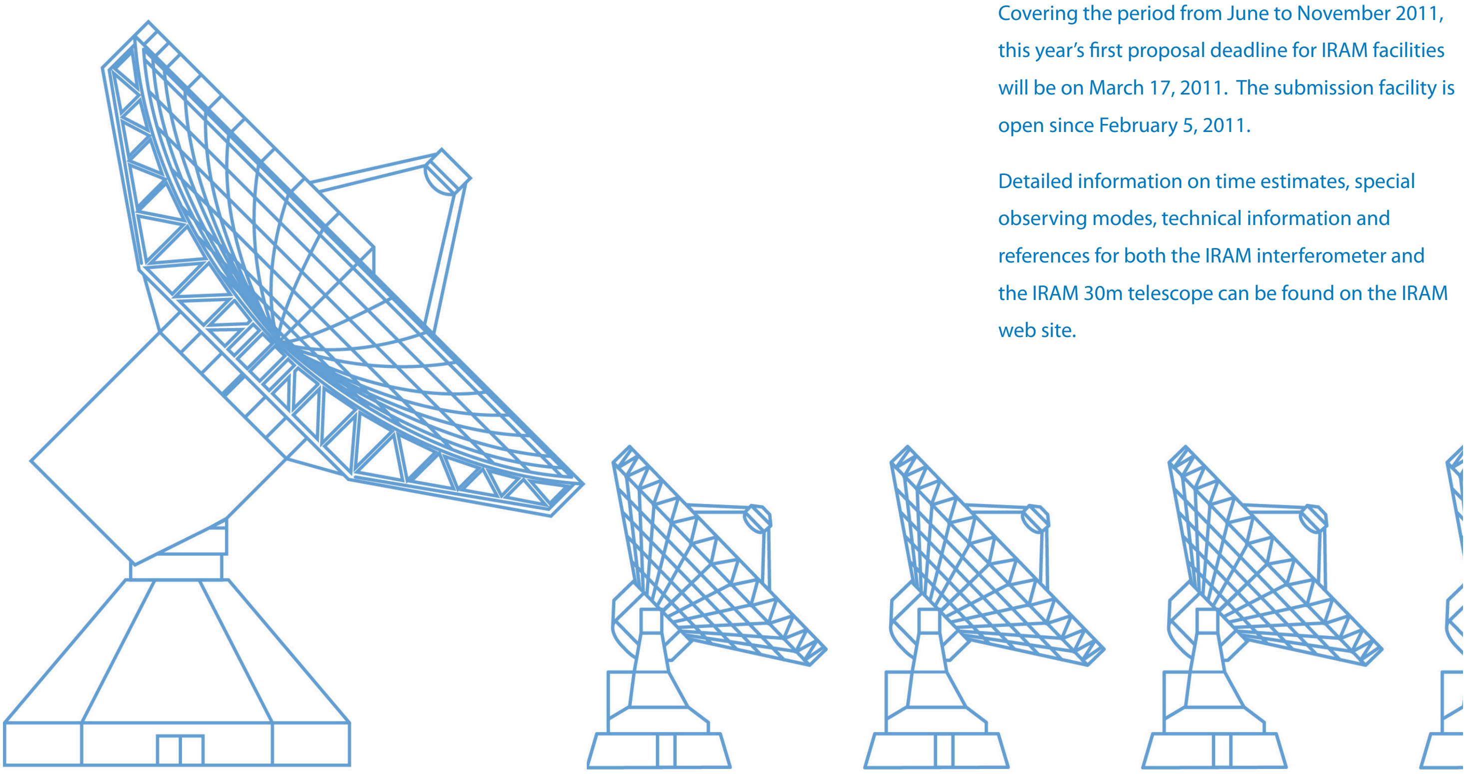
Facilities

Call for proposals for the 30m Telescope and the Plateau de Bure Interferometer

By Clemens Thum and Jan Martin Winters

Covering the period from June to November 2011, this year's first proposal deadline for IRAM facilities will be on March 17, 2011. The submission facility is open since February 5, 2011.

Detailed information on time estimates, special observing modes, technical information and references for both the IRAM interferometer and the IRAM 30m telescope can be found on the IRAM web site.



The deadline for submission of observing proposals on IRAM telescopes, both the interferometer and the 30m, is

17 March 2011, 17:00 CET (UT + 1 hour)

The scheduling period extends from 1 June 2011 to 30 November 2011. Proposals should be submitted through our web-based submission facility. Instructions can be found on our web page at http://www.iram.fr/GENERAL/submission/submission.html

Detailed information on time estimates, special observing modes, technical information and references for both the IRAM interferometer and the IRAM 30m telescope can be found on the IRAM web site and then following the links under Proposals. The submission facility will be opened about three weeks before the proposal deadline. Proposal form pages and the 30m time estimator are available now.

Please avoid last minute submissions when the network could be congested. As an insurance against network congestion or failure, we still accept, in well justified cases, proposals submitted by:

* fax to number: (+33) 476 42 54 69
* ordinary mail addressed to:
  IRAM Scientific Secretariat,
  300, rue de la piscine,
  F-38406 St. Martin d'Hères, France

Proposals sent by e-mail are not accepted. Color plots will be printed/copied in grey scale. Proposals are evaluated on the basis of the paper copy. If color is considered essential for the understanding of a specific figure, a respective remark should be added in the figure caption. The referees may then consult the electronic version of the proposal.

Soon after the deadline the IRAM Scientific Secretariat sends an acknowledgement of receipt to the Principal Investigator of each proposal correctly received, together with the proposal registration number. Note that the web facility allows cancellation and modification of proposals before the deadline. The facility also allows to view the proposal in its final form as it appears after re-compilation at IRAM. We urge proposers to make use of this feature as we always receive a number of corrupted proposals (figures missing, blank pages, etc.).

Valid proposals contain the official cover page, one or more pages of technical information, up to two pages of text describing the scientific aims, and up to two pages of figures, tables, and references. Normal proposals should not exceed 6 pages, except for additional technical pages. Longer proposals will be cut. We continue to call for Large Observing Programmes. The Large Programmes may have up to 4 pages for the scientific justification, plus cover page, the technical pages, and 2 pages for supporting material.

The current versions of the proposal templates for the 30m telescope prop-30m.tex and for the interferometer prop-pdb.tex must be used together with

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the current LATEX style file proposal.sty. All three files may be downloaded from

http://www.iram.fr/GENERAL/submission/proposal.html

Do not change the font type or size, and do not manipulate the style file. In case of problems, contact the IRAM secretary (e-mail: berjaud@iram.fr). Please, also indicate on the proposal cover page whether your proposal is (or is not) a resubmission of a previously rejected proposal or a continuation of a previously accepted interferometer or 30m proposal. We request that the proposers describe very briefly in the introductory paragraph (automatically generated header "Proposal history:") why the proposal is being resubmitted (e.g. improved scientific justification) or is proposed to be continued (e.g. last observations suffered from bad weather).

Short spacing observations on the 30m telescope should directly be requested on the interferometer proposal form. A separate proposal for the 30m telescope is not required. The interferometer proposal form contains a bullet, labelled "30M short spacings" which should then be checked. The user will be prompted to fill in an additional paragraph in which the scientific need for the short spacings should be described. It is essential to give here all observational details, including size of map, sampling density and rms noise, spectral resolution, receiver configuration, and time requested.

A mailing list has been set up for astronomers interested in being notified about the availability of a new Call for Proposals. A link to this mailing list is on the IRAM web page. The list presently includes all principal investigators of proposals for IRAM telescopes during the last 2 years. Please verify that your email address in this list is correct.

Travel funds for European astronomers

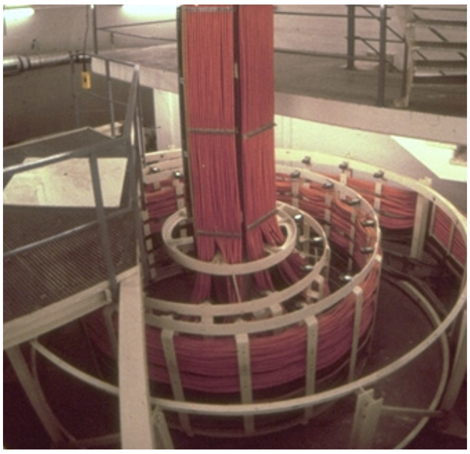
by Roberto Neri and Clemens Thum

Observations using IRAM telescopes continue to be supported by RadioNet under the European Framework Programme 7. A budget, somewhat reduced compared to the 2004 - 2008 period, is available for travel by European astronomers through the Trans National Access (TNA) Programme.

As before, travel may be supported to the 30m telescope for observation (contact: C. Thum) and to Grenoble for reduction of interferometer data (contact: R. Neri). Detailed information about the eligibility, policies, and travel claims can be found on the RadioNet home page. The Principal Investigators of IRAM proposals eligible for TNA funding will be informed individually.

Call for observing proposals on the 30m Telescope

By Clemens Thum and Carsten Kramer



Summary

Proposals for three types of receivers will be considered for the coming summer semester (1 June 2011 to 30 November 2011):

1. the heterodyne receiver EMIR, consisting of dual-polarization mixers, operating in the four bands at 3, 2, 1.3, and 0.9mm wavelengths.
2. the 9 pixel dual-polarization heterodyne receiver array, HERA, operating at 1.3mm wavelength.
3. the MAMBO2 bolometer array with 117pixels operating at 1.2mm.

Emphasis will be put on observations at the longer wavelengths. Observations at wavelengths $\leq$ 1.3 mm will be scheduled toward the end of the semester in pools which allow to optimize the observations according to weather conditions. The pool structure was successfully improved by including a new queue for projects requiring the "best weather". Projects in this new queue are observed when the column of precipitable water vapor drops below 2mm and when other practical conditions (wind, atmospheric stability) are fulfilled.

We continue to call for Large Programmes using any of the three instruments.

Proposers are requested to use the time estimators which are available online via the IRAM 30m webpage.

What is new?

Fourier Transform Spectrometers

The implementation and commissioning of the new Fast Fourier Transform Spectrometers (FTS) is proceeding as planned. Two blocks of FTS are available since 1-Dec-2010, each block covering a contiguous 4 GHz band. The spectral resolution of these FTS is fixed to 195 kHz.

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This new backend is available for regular observations with EMIR in all observing modes, except for polarimetry.

Work is in progress (1) to increase the FTS bandwidth up to 32 GHz (at 195 kHz resolution) and (2) to provide a higher spectral resolution of 50 kHz. This change involves also a major upgrade of the IF sytem. If installation and commissioning work out as planned, we expect that the expanded FTS features become available during the summer semester. A more detailed description of the 32GHz FTS system is given above.

EMIR Upgrade

The large bandwidth of EMIR will be increased further during the semester. The mixers used for the 230 and 330 GHz bands will be replaced by dual sideband (2SB) mixers of the design already installed for the E090 band. The E230 and E330 bands will then also have 32 GHz bandwidth each (2 sidebands x 2 polarizations x 8 GHz of instantaneous bandwidth).

New continuum backends

We are installing new broadband continuum backends which fully cover the bandwidth provided by EMIR. The current continuum detectors have a bandwidth of only 1 GHz.

As none of the above three upgrades have yet been commissioned on the telescope, we ask the proposers to base their estimates on the current available system. Use of the upgraded system will be on a 'shared risk' basis. Further information about the upgrades will be provided in due time to the community. Observers should make it clear in their proposals if the expanded features are essential in reaching their goals.

The complete text

of the Call for Proposals can be retrieved as a pdf file from the IRAM web site at http://www.iram.fr/GENERAL/calls/s11/s11.pdf.

Non-trivial changes with respect to the previous Call for Proposals are marked in red.

Call for observing proposals on the Plateau de Bure Interferometer

by Jan Martin Winters

Conditions for the next summer period

In contrast to the previous years, no major technical upgrades are foreseen during the upcoming summer period 2011. During the regular antenna maintenance period, scientific observations will mostly be carried out with the five element array. We plan to start the maintenance at the latest by the end of May and to schedule the 5D configuration between June and October.

We strongly encourage observers to submit proposals that can be executed during summer operating conditions. To keep the procedure as simple as possible, we ask to focus on:

- observations requesting the use of the 2mm and 3mm receivers
- circumpolar sources or sources transiting at night between June and September
- observations that qualify for the 5D, 6D, and 6C configurations.

Configurations

Part of the projects will be scheduled at the end of the summer period when the six-element array (likely in C-configuration) is expected to be back to operation. Projects that should be observed with a subset of the five-element array will be adjusted in uv-coverage and observing time.

Schedule

Configurations planned for the summer period are:

Name	Stations
5Dq	W08 E03 N07 N11 W05
6Dq	W08 E03 N07 N11 N02 W05
6Cq	W12 E10 N17 N11 E04 W09

Receivers

All antennas are equipped with dual polarization receivers for the 3mm, 2mm, 1.3mm, and 0.8mm atmospheric windows.

The frequency range at the center of the IF band is 80GHz to 116GHz for the 3mm band, 129GHz to 174GHz for the 2mm band, 201 to 267GHz for the 1.3mm band, and 277 to 371GHz for the 0.8mm band.

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Facilities

The complete text of the Call for Proposals can be retrieved from the IRAM web site at http://www.iram.fr/GENERAL/calls/s11/s11.pdf.

Results

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be multiplied by a similarly large factor.

This expectation is confirmed by the first analysis and study of the strongest sources, which were uncovered so far in H-ATLAS, and were shown to be at high redshifts, i.e. 1.5<z<3 (Negrello et al. 2010). This result triggered a wealth of follow-up observations at all wavelengths to further characterize the nature of these high-z sources as well as the properties of the lensing galaxies.

Prominent amongst these observations are those done at sub/millimetre wavelengths. The strength of the sources detected by Herschel together with recent technological developments at the sub-millimetre facilities has opened a new area. In particular, the redshift of these sources, which are enshrouded in dust, can now directly be determined from the measurement of a series of CO lines. To date the distances to more than 10 sources uncovered in the Herschel deep-field surveys have been measured using this technique, at the CSO and now APEX (with ZSpec), the GBT (with Zspectrometer), CARMA and the Plateau de Bure interferometer (with the newly installed correlator, WideX).

As an example, the redshift of the most prominent, highest redshift source found so far (ID.141) was 'blindly' determined at the Plateau de Bure interferometer in a frequency sweep that required six (short integration) settings to search for the CO lines, resulting in the detection of the CO 4-3 and 5-4 transitions, yielding a redshift z>4 (Cox et al. 2011). Subsequent observations done with APEX enabled the detection of the fine-structure line of C^+. The detection of CO lines using the Plateau de Bure interferometer enabled robust redshift determination of five other Herschel lensed sources in the redshift range 2<z<3 (Negrello et al. 2010; Riechers et al. 2011).

It should be noted that, using EMIR at the 30-meter telescope, the redshift of another exceptionally strong source, that was serendipitously discovered with MAMBO, was measured to be at z=3.93 based on the detection of CO lines (Lestrade et al. 2010). The determination of the redshift allows further searches to be performed, especially of weaker lines, to probe the physical conditions and the chemistry of the molecular gas in these systems.

A recent example of a follow-up study is that of the lensed sub-millimetre galaxy HLSW-01 at z=2.957, one of the strongest HerMES sources found so far, which was mapped in the 5-4 transition of CO using the Plateau de Bure interferometer. The observations spatially resolve the molecular gas and the dust continuum emissions into four lensed images with a maximum separation of 9", revealing the internal gas dynamics in this system.

Another example is the detection of water in the 2_{02}–1_{11} transition of para-H_2O in the source H-ATLAS ID.17b (z=2.3052), using the newly installed Band 4 receivers at the Plateau de Bure interferometer (Omont et al. 2011). This result confirms a previous, tentative detection done at the CSO (Lupu et al. 2011). The intrinsic water line luminosity in ID.17b is comparable to that of the local ultra-luminous starburst galaxy Mrk 231 and the excitation of the H_2O levels are probably similar in both objects. This detection shows that some of the Herschel lenses can harbor a rich chemistry that remains to be studied in the future with ALMA and NOEMA.

The above successes lead to a series of new projects that are currently being scheduled at both the 30-meter telescope and the Plateau de Bure interferometer. For instance, a survey using the bolometer MAMBO-2 is currently in progress to measure the 1.2 mm continuum emission of about 200 lens candidates uncovered in H-ATLAS and HerMES. The aim of these surveys is to narrow down the range of the

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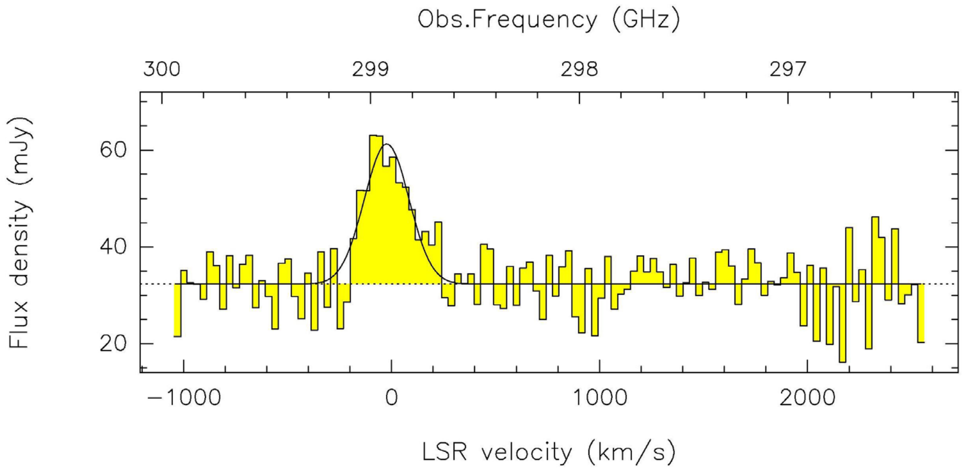
Spectrum of the water emission in the Herschel source H-ATLAS ID.17b at z=2.3052.

The line corresponds to the para H_2O 2_{02} -1_{11} emission line redshifted at 299 GHz. It was obtained at the Plateau de Bure interferometer using the newly installed band 4 receiver (Omont et al. 2011).



photometric redshifts of these sources in order to search with greater efficiency for CO lines and estimate accurate distances to these objects. As of today, more than 35 high-z sources have been detected with flux densities at 1.2mm in excess of 10 mJy.

At the Plateau de Bure interferometer, a comprehensive imaging project is underway that will map a series of lensed high-z galaxies at high-resolution. The goal is to determine dynamical, structural and excitation properties at resolutions comparable to those of individual giant molecular clouds within these intensely star-forming galaxies, putting what has been learnt from the dramatic images of SMMJ2135 (the 'Cosmic Eyelash') on a firmer statistic footing. High quality optical images will also allow accurate modelling of the lensed system and their dark matter properties.

The examples of these recent studies provide us with a first glimpse of what can be expected in the future from this unique sample of hundreds of Herschel high-z lensed galaxies: today with Plateau de Bure, soon in the frame of the ALMA Early Science, and later with the fully operational ALMA and NOEMA. The enhanced capabilities of the latter facilities will allow countless extensions for each of the topics mentioned above, including: blind CO redshift determination and search for objects at the highest redshifts; high-resolution imaging and dynamics of strongly lensed galaxies; comprehensive studies of dark matter in high-z deflectors; high sensitivity molecular (and atomic) spectroscopy; molecular gas in high-z Active Galactic Nuclei; search and study of exceptional, high-z lensed systems: highest magnifications; double object lensing by the same deflector; radio-loud sources; or high-z masers.

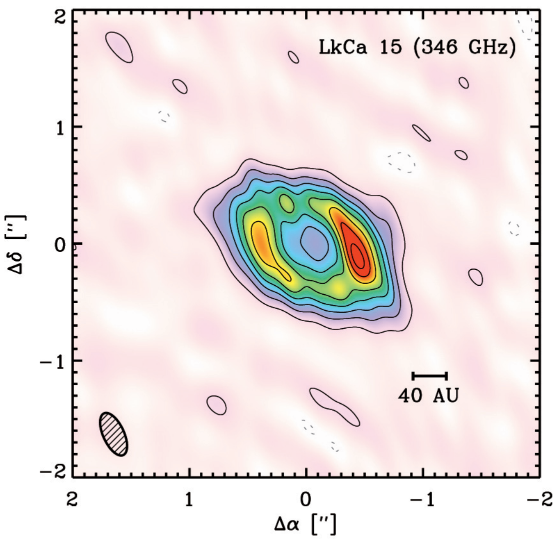
Imaging the proto-planetary disk around LkCa15: the highest spatial resolution image yet obtained with the Plateau de Bure interferometer

by Sean M. Andrews

Hundreds of extra-solar planets have been discovered around nearby main-sequence stars. A massive effort is underway to find more planets, determine their key properties, and explain demographic trends with models of their formation. But associating the current extra-solar planet properties with their formation epoch can be problematic, since the formation process is intimately associated with the initial conditions in the progenitor circumstellar disk. Ideally, the properties of mature extra-solar planet systems could be compared with those for their younger counterparts that are 'caught in the act' of formation, still embedded in their natal disks. The results would refine our understanding of planet formation timescales and help characterize how extra-solar planet properties are shaped by early interactions with disk material.

While the direct detection of a planet orbiting a young star is currently a challenge, the presence of a giant planet can be inferred indirectly through its dynamical influence on the structure of the remnant disk material. A sufficiently massive planetary companion can open a gap that impedes the inward flow of mass through the disk, quickly producing a low-density cavity at the disk center. The size of the cavity is set by the planet orbit, and the amount of material inside it depends in some way on the planet mass. Therefore, observational constraints on the sizes and mass contents of these disk cavities can offer some initial insights into the orbital architectures and masses, respectively, of planetary systems at ages of only 1 million years. The best way to measure such disk structures is with high-quality, sensitive, and high angular resolution observations of the millimeter dust continuum emission.

Using the new band 4 receivers and WideX correlator in the A configuration, the Plateau de Bure interferometer has recently resolved the large cavity (R = 50 AU) in the proto-planetary disk around the young star LkCa15 at a continuum frequency of 346 GHz. This image has the highest angular resolution yet achieved with the Plateau de Bure interferometer. While a detailed modeling effort will be required to interpret the properties and underlying origins of this cavity, these exceptional data represent a first step in the development of a new, indirect method for identifying potential young extra-solar planet systems through the millimeter imaging of their associated disk structures.



A naturally-weighted PdBI A-array aperture synthesis image of the 346 GHz dust continuum emission from the LkCa 15 disk.

The 0.39" x 0.18" synthesized beam is shown in the lower left, with a 40 AU scale bar labeled to the lower right for reference. Contours are drawn at 2.7 mJy/beam intervals, beginning at 1.8 mJy/beam. From Sean M. Andrews et al. (in preparation).

Results

Recent science highlights with EMIR and HERA: FTS mapping survey of the W43 molecular complex

by Quang Nguyen-Luong and Frédérique Motte on behalf of the W43 Large-Program Consortium

The project "Origins of molecular clouds and star formation in W43" is a large program of IRAM that started in the summer semester of 2009. The goal of the project is to survey the W43 molecular complex in ^{13}CO, $C^{18}O$ with HERA receiver and HCO^+, $H^{13}CO^+$ with EMIR receiver. We aim to link the kinematics of low-density (10^3 cm^{-3}) clouds to the smaller-scale high-density (10^5 - 10^6 cm^{-3}) sites of star formation. These observations will be compared with the quantitative predictions made by simulations of molecular cloud formation via converging flows.

As part of the project, W43 has been mapped in HCO^+ 1–0 and $H^{13}CO^+$ 1–0 in on-the-fly mapping mode with the EMIR receiver in the winter semester 2010. By the beginning of this semester, 8 units (out of 32 in total) of the new FTS backend were available, which cover 2x4GHz with a fixed resolution of 195 kHz. This new capability allowed us to map a large region not only in the two proposed lines but also in more than 20 transition lines simultaneously. Until then, 3mm multi-transition line-mapping with high resolutions and large bandwidths was available only with the 22m-MOPRA telescope in Australia.

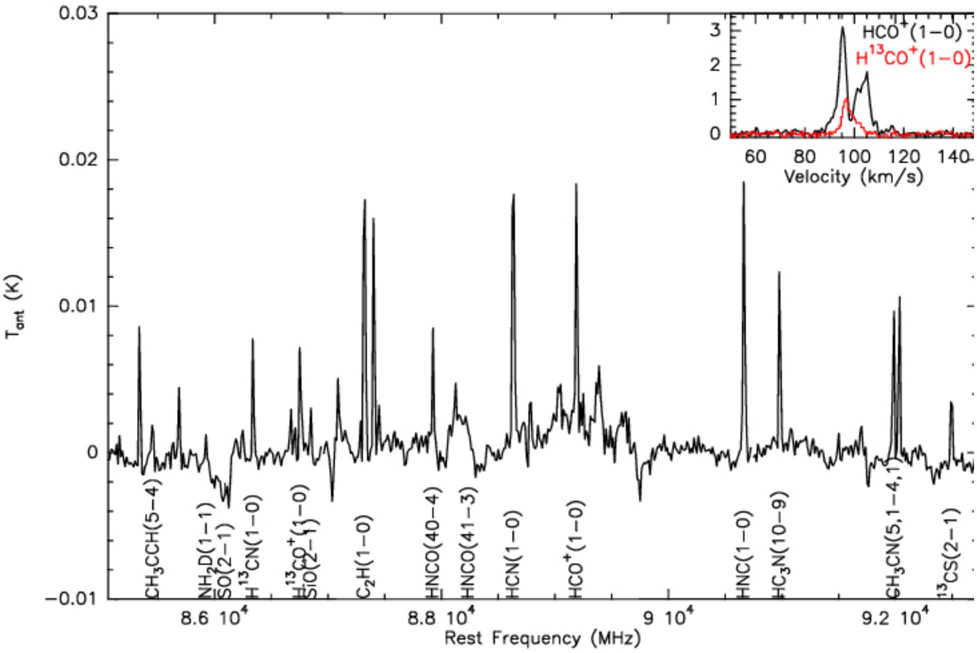


Fig. 1: Spectrum averaged over the entire area and a typical spectrum of the infall profile.

W43 has recently been identified and characterized as one of the most extreme molecular cloud complex of the Milky Way, located at only ~ 6 kpc from the Sun (Nguyen-Luong et al. 2011). W43 molecular cloud is massive ($7x10^6 M_{sun}$ within a 140 pc equivalent diameter), highly-concentrated ($8x10^5$ M_{sun} within a ≤ 5 pc star-forming sites) and very dynamic (ΔV ~ 20 km/s). The star-formation activity of W43 is suggested to be very high, up to levels typical of starburst (star formation rate ~ 0.1 M_{sun}/yr). This rate is in agreement with the estimates made on the subregion W43-Main that qualifies as a ministarburst (Motte et al. 2003, ApJ, 582, 277).

W43 was mapped with the EMIR receiver and the FTS backend from 85 GHz to 93 GHz with two different frequency settings to cover a 8 GHz bandwidth. The average spectrum is shown in Fig. 1, in which strong detection lines are marked. In the sub-panel of Fig.1, spectra of two isotopologues of HCO^+ 1–0 are displayed: the optically thick line HCO^+ 1–0 in black and the optically thin line $H^{13}CO^+$ 1–0 in red. This molecule is a good tracer of dense core in which stars are forming. The red-shifted self-absorbed line profile of HCO^+ line combined with the single-peak profile of the $H^{13}CO^+$ line is a typical infall signature of the clump which is actually accreting material to form stars. With our large-scale mapping, we are able to derive a 2D infall-velocity field starting from the clump and extending out to the lower density regions.

Various molecular lines mapped in this survey trace gas at different temperatures, density regimes and likely at different evolutionary stages (see Fig. 2 for example). For example, SiO emission often traces the shock gas emanating from the outflows of the young protostar. CCH, on the other

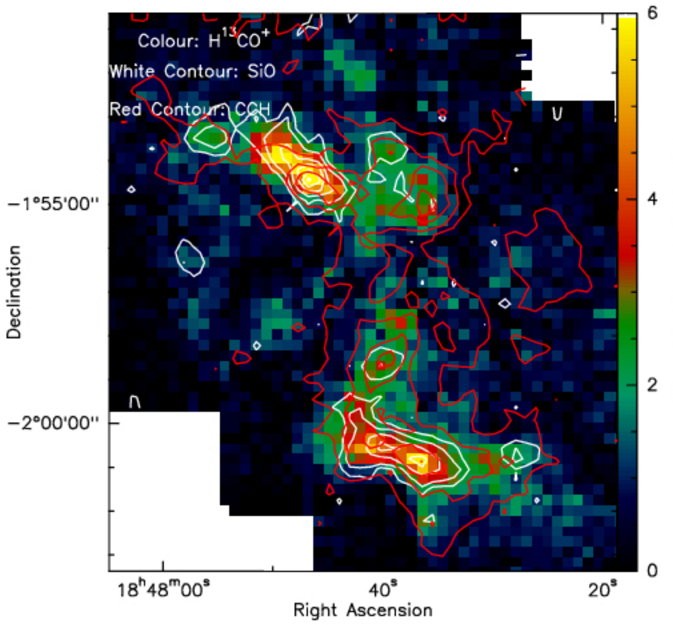


Fig. 2: Integrated emissions of $H^{13}CO^+$ 1-0 (Colour), SiO (2-1) (White contour), CCH (1-0) (Red Contour).

continued on next page

hand, is dominant in diffuse clouds or prestellar cores. The difference between the molecules are demonstrated in Fig. 2: SiO emission coincides well with the brightest regions in $H^{13}CO^+$ emission whereas CCH peaks at different locations, probably at a different evolutionary stage.

By exploiting this large data set obtained from the 8 GHz survey, we will be able to study star formation and molecular-cloud formation in W43 in a systematic way from the tenuous clouds traced by CO to highly-concentrated star formation seeds traced by $H^{13}CO^+$ and others. Our first endeavor will be to investigate the kinematic information that the data implies by comparing these results with the numerical simulations of converging flows. Other sciences resulted from this survey will include studying photon-dominated region and chemical differentiation. A consortium meeting is foreseen for the spring 2011 to discuss how to exploit the data.

The W43 mapping team is an international collaboration lead by Frédérique Motte (CEA Saclay) and Peter Schilke (Universität zu Köln). Team members are Q. Nguyen-Luong, N. Schneider (CEA Saclay); S. Bontemps (Obs. Bordeaux); F. Schuller, K. Menten, F. Wyrowski (MPIfR Bonn); F. Heitsch (UMichigan); P. Hennebelle (ENS Paris); R. Banerjee (UHeidelberg); M. Gonzalez, C.Kramer (IRAM/Granada); P. Carlhoff, R. Simon (UKöln); H. Beuther, Th. Henning (MPIA); L. Bronfman (Univ. de Chile); M.Walmsley (OAA); A. Zavagno (OAMP).

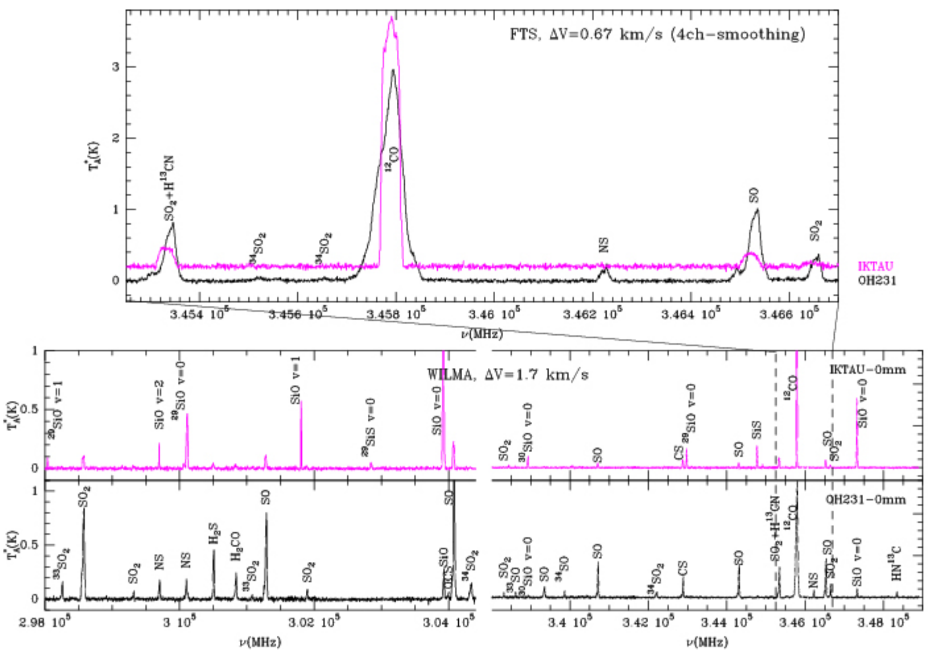
Molecular complexity in oxygen-rich circumstellar envelopes

by C. Sanchez Contreras and collaborators

Circumstellar envelopes around evolved stars are extraordinarily efficient factories of molecules and dust particles that will enrich eventually the interstellar medium. To date, most chemistry studies have focused on carbon-rich stars that are known to display a rich molecular variety.

To explore the chemistry of oxygen-rich evolved stars, we started a millimeter line survey with EMIR in two well-known objects, IK Tau and OH231.8+4.2. Their spectra show hundreds of molecular lines (including many new species) indicating that oxygen-rich stars can be as chemically diverse and rich as their carbon counterparts. This is illustrated by the spectra around 300 and 343 GHz that were obtained this winter with band 4 and the FTS. The many species identified so far include, for instance, molecules such NH_3, NS, OCS, HCN, HNCS, ions such as HCO^+ and N_2H^+, a great number of isotopologues as well as complex organic molecules.

Both stars show remarkable differences in their spectra. Some of the intense transitions of C, N, and S-bearing species (including complex organic molecules) detected in OH231.8+4.2 are absent in the spectrum of IKTau, whereas molecules such as NaCl, PO, and PN, which are observed in IKTau are not seen in OH231.8+4.2. These variations could be due to the characteristics of the shocks in these objects that result in different chemistries.



Data subset of EMIR spectra at 0.85mm of the O-rich stars IK Tau and OH231.8+4.2 obtained in January 2011 as part of our on-going mm-wavelength spectral line survey of O-rich evolved stars.

Bottom: Selected spectra obtained with WILMA around 300 and 343GHz. The molecular species responsible for some of the most intense transitions detected are labeled.

Top: Zoom of a smaller frequency range (indicated by vertical dashed lines in the bottom panels) showing higher spectral resolution spectra obtained with FTS.

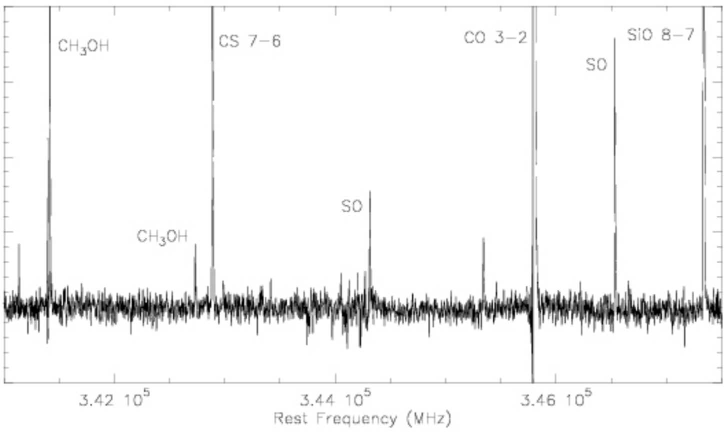
Results

Molecular shocks in the protostar L1157-B1

by Bertrand Lefloch

Shocks from proto-stellar outflows play an essential role in the dynamical and chemical evolution of molecular clouds. Studying magneto-hydrodynamical (MHD) shocks requires a detailed understanding of both the physical and chemical conditions of the gas because of the interplay between the gas dynamics and the chemistry. The outflow driven by the protostar L1157 is the prototype of a chemically active shock and its strong southern bowshock, B1, has become a laboratory for the study of MHD shocks.

We have started an unbiased spectral survey of this region using HIFI on the Herschel Space Observatory (Lefloch et al. 2010). This sub-millimeter survey, which gives access to key spectroscopic signatures of the shocked gas, is complemented with millimeter data obtained at the 30-meter telescope. The combined Herschel and 30-meter data will result in a complete and unique census of the chemical complexity of a bowshock, probe the physical conditions in the cold ambient and post-shocked gas and serve as a reference for modeling MHD shocks.



Spectrum of the bowshock B1 in the protostar L1157 around 345 GHz obtained with band 4 and WILMA at the 30-meter telescope.

The spectrum of L1157-B1 is extraordinary rich as is illustrated by the data collected around 340 GHz which were obtained using the band 4 at the 30-meter telescope and are displayed in the accompanying figure. Many strong lines of various molecules are present, including CO, CS, SO, SiO and methanol that trace the warm and chemically enriched gas. Together with the higher CO and water transitions detected with HIFI, these data will enable to constrain the excitation conditions and understand the chemical richness in the shocked molecular gas of L1157-B1.

MAMBO2 - Science results from the October 2010 pool session

by Manuel Gonzalez, Guillermo Quintana-Lacaci and Carsten Kramer

The following presents science results obtained during the MAMBO 2 pool weeks of the summer semester 2010 which started at the end of last October. After a test run of the NIKA bolometer, MAMBO2 was reinstalled and recommissioned by Robert Zylka, Albrecht Sievers, Santiago Navarro, Dave John, and Guillermo Quintana-Lacaci.

A total of 351 hours were allocated for the summer pool. There were excellent weather periods, although a large amount of time was lost due to bad weather. In total, 86 hours were used for bolometer observations and most of the projects could obtain results. The average of the percentage of time used versus time allocated was 43%. The science projects covered a wide variety of areas like star formation, evolved stars, local galaxies, and sources at high-redshift. Two projects could be completed.

The two science results described below were obtained for the first one in on-off observing mode and for the other in mapping mode.

Thermal emission from colliding winds in Wolf-Rayet binary systems

Wolf-Rayet stars emit free-free emission that is detectable at radio and also millimeter wavelengths. In Wolf-Rayet binary systems, a wind-wind colliding region (WCR) is expected to have a thermal and/or non-thermal contribution to the radio and millimeter emission. In closed systems (orbital period < 1 month), the non-thermal emission is expected to be absorbed.

Theoretical studies suggest that, in these systems, a radiative WCR could be able to contribute, and even dominate the spectrum from centimeter to millimeter wavelengths. In this case, from the comparison of flux densities from millimeter observations, with those extrapolated from centimeter wavelengths, it is possible to identify any excess of emission with a thermal contribution from a WCR.

Five close WR binaries were detected with MAMBO2 at 1.2 mm. For two of the observed sources (WR 139 and WR 156) the results show hints of an excess over the expected free-free emission. Several factors, like clumps and internal shocks may result

continued on next page

Results

in a similar excess. More detailed analysis are required in order to distinguish between these scenarios.

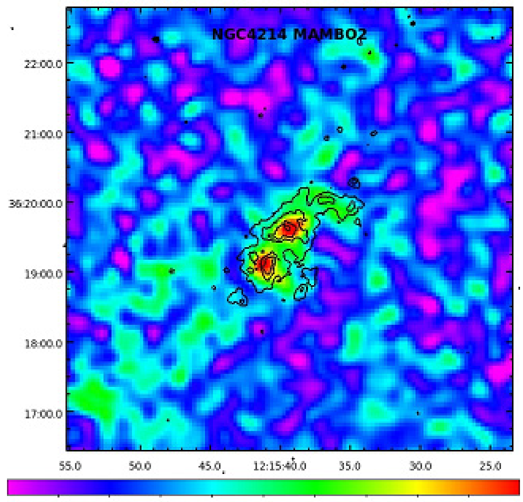
G. Montes (IAA-CSIC), M.A. Pérez-Torres (IAA-CSIC), A. Alberdi (IAA-CSIC), R.F. González (CRyA-UNAM), and M.I. Rodriguez (IAA-CSIC).

Mapping the dust emission in the starbursting dwarf galaxy NGC4214

The starbursting dwarf galaxy NGC 4214 was mapped with MAMBO. The 1.2 mm continuum emission of this dwarf galaxy shows a maximum corresponding to the position of two young star clusters. With ages of approximately 3 and 5 Myr, these clusters are surrounded by HII regions and Photon-Dominated-Regions, which are traced by the 8µm emission from Spitzer. One of them is dust-enshrouded (the south-eastern object) while the other has a shell-like structure. In addition to these two peaks, 1.2mm emission is also clearly detected in a faint arm towards the North-West which is also traced at 8µm.

Lisendfeld, U. , Hermelo, I. et al. (Unversity of Granada).

The figure shows the map at 1.2mm taken with MAMBO, smoothed to a spatial resolution of 18". Overlayed are contours of the 8µm emission from Spitzer IRAC data.



Developments

3 mm band dual polarization HEMT receiver prototype for the Pico Veleta telescope

by Patrice Serres

A 3 mm band (84-116 GHz) HEMT receiver prototype was designed and constructed at IRAM and it was installed on the Pico Veleta 30 m telescope during the period Aug. 17th-24th, 2010.

This receiver allows to test the 3 mm band cryogenic InP MMIC amplifiers technology and to compare its performance with that delivered by the Sideband Separating SIS mixers (2SB) already available at the site (E0 band of the EMIR receiver).

The HEMT amplifiers technology provides the following advantages over the 2SB technology:

a) an extremely wide instantaneous IF band, larger than 32GHz (against the 16 GHz, 8 GHz per sideband, currently obtained with the 2SB);

b) a very high image sideband rejection, better than 30 dB (against typical values of 10-15 dB achieved with the 2SB);

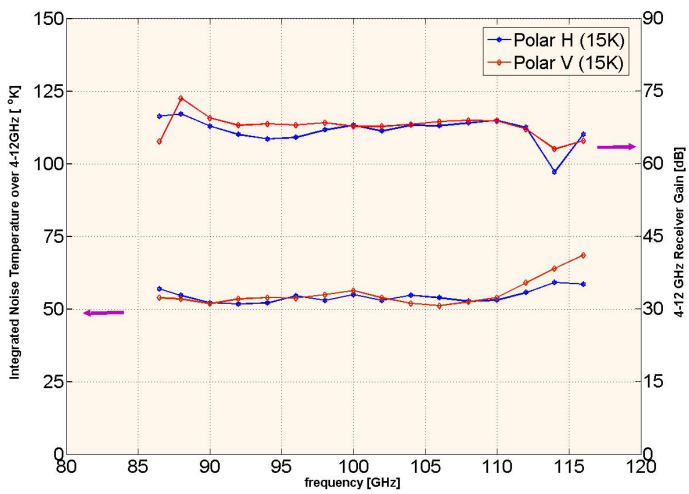
c) requires cooling to only 15 K (rather than 4 K, therefore greatly simplifying the cryogenics complexity);

d) the LO distribution and down conversion hardware can all be located at room temperature (hence minimizing the number of parts at cryogenic temperature).

Therefore, the 3 mm HEMT receiver prototype allows to explore the potential for employing this technology into future IRAM observatories.

Inside the telescope cabin, a movable flat mirror switches the telescope beam from the HERA receiver to the 3mm HEMT receiver where it is redirected inside the cryostat and coupled into a single corrugated feedhorn by a dielectric lens that ensures a –12dB frequency independent illumination of the sub-reflector. The feed horn square waveguide output is cascaded with an Orthogonal Mode Transducer (OMT) that splits the two orthogonal linear polarizations into two independent single-mode rectangular waveguides. The OMT fits more easily in a cooled receiver than a polarization splitting wire-grid and provides almost perfect alignment on the sky between the two orthogonal polarizations as only one feed horn is required. Two MMIC HEMT amplifiers, cryogenically cooled at 15K, amplify the 3mm signal in each polarization channel. At room temperature, the signal is then filtered, down-converted and

Receiver noise temperature (left scale) and gain (right scale) integrated over the 4-12 GHz IF band. The blue curve refers to the horizontal polarization, the red one to the vertical polarization.

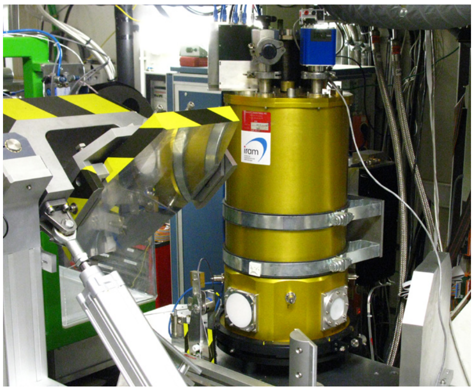


Developments

further amplified to provide a final 8GHz IF bandwidth across 4-12GHz, which is compatible with the currently available IF processor.

The noise temperature (SSB) of the HEMT receiver measured in front of the cryostat window is about 55 K across the whole 84-116 GHz frequency range (see Figure page 12), slightly worse than that provided by the 2SB SIS mixer technology. The measured total power stability (Allan deviation) is below 3.10^{-4} for integration times in the range 1-100 sec, better than the specification of the ALMA receivers.

The receiver was successfully used to perform preliminary astronomical observations.



84-116 GHz HEMT receiver installed in the receiver cabin of the IRAM Pico Veleta telescope.

5th generation of Plateau de Bure correlators in developing phase

by Marc Torres

The 4th generation correlator at the Plateau de Bure observatory, WideX, has just completed one year of flawless operation. This is partly due to the engineering but also because during its definition stage, a single-mode design was adopted. Thus, WideX development did not face the technical difficulties usually encountered when trading resolution versus bandwidth or bandwidth versus a certain number of available antennas. In consequence, the costs of WideX could be reduced significantly whereas its reliability improved and the time-to-sky shortened.

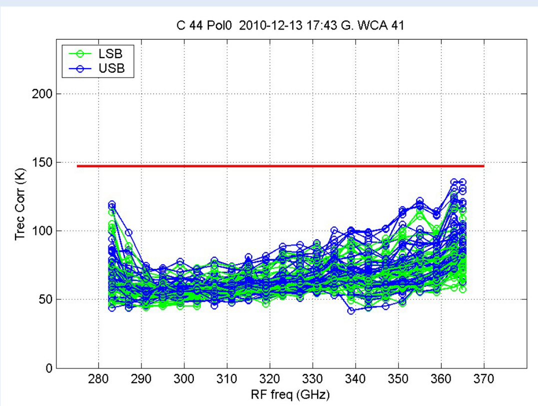
While the Plateau de Bure interferometer produces stunning results with WideX, IRAM engineers at the BackEnd lab have already started work on the next generation of correlators. The 5th generation will not be an "eXpress" design with a fixed configuration but will have to adapt itself to a constantly varying number of antennas during its whole lifetime, each of the antennas delivering an increasing bandwidth. This will require new technologies such as fast analogue to digital conversion in the domain of electronics.

During the last months, the BackEnd lab procured state-of-the-art chips and built a test platform named DiFER to interconnect them. Originally, the chips had not been designed for radio astronomy, but for the telecom business where the requirements are quite differently. The purpose of DiFER is to verify if these chips can be adapted and serve as the key building blocks for the future correlator as well as define the maximal speed at which they can be operated.

Correlator evolution at the Plateau de Bure interferometer

Year	Bandwith	Antennas	Channels	MACS*
1986	4 x 80 MHz	3	768	0.061
1992	6 x 160 MHz	4	18.432	0.737
1995	6 x 160 MHz	5	30.720	1.23
2000	8 x 320 MHz	6	122.880	9.83
2009	4 x 2000 MHz	8	3.670.016	917

* Number of multiply-accumulate in Tera-operations per second



Middle of ALMA Band 7 cartridge production achieved

IRAM is responsible for the production (component procurement, assembly and test) of 65 + 8 spare state-of-the-art ALMA band 7 cartridges, covering the 275-373GHz frequency range. The middle of the production was achieved towards the end of 2010. Nineteen receivers have been delivered and accepted by the project since January 2010.

Fig.: Noise temperature at 22 Local Oscillator frequencies of 36 different ALMA Band 7 cartridges (C9 to C44). The measured noise temperatures, integrated over the 4-8 GHz IF bandwidth, refer to one of the two polarisation channels and are all below the noise specification limit (indicated by the horizontal red line).

Developments

EMIR band 3 mixer upgrade

by Doris Maier, Quentin Moutote, Julien Reverdy, Dominique Billon-Pierron and Arnaud Barbier

In spring 2009 IRAM installed its Eight MIxer Receiver (EMIR) at the 30m telescope at Pico Veleta in Spain. Since then EMIR observes successfully in four frequency bands centered around 100, 150, 230, and 305 GHz, respectively.

Band 3 of EMIR (200–267 GHz) is still equipped with single-sideband (SSB) mixers using movable backshorts in the waveguide behind the mixer chip to tune out the image sideband and delivering one IF output of 4–8 GHz, whereas current state-of-the-art receivers employ sideband-separating (2SB) mixers with two IF outputs and twice as large IF bands. EMIR's Band 1 is already equipped with such a sideband-separating mixer, which has been developed within the European project AMSTAR.

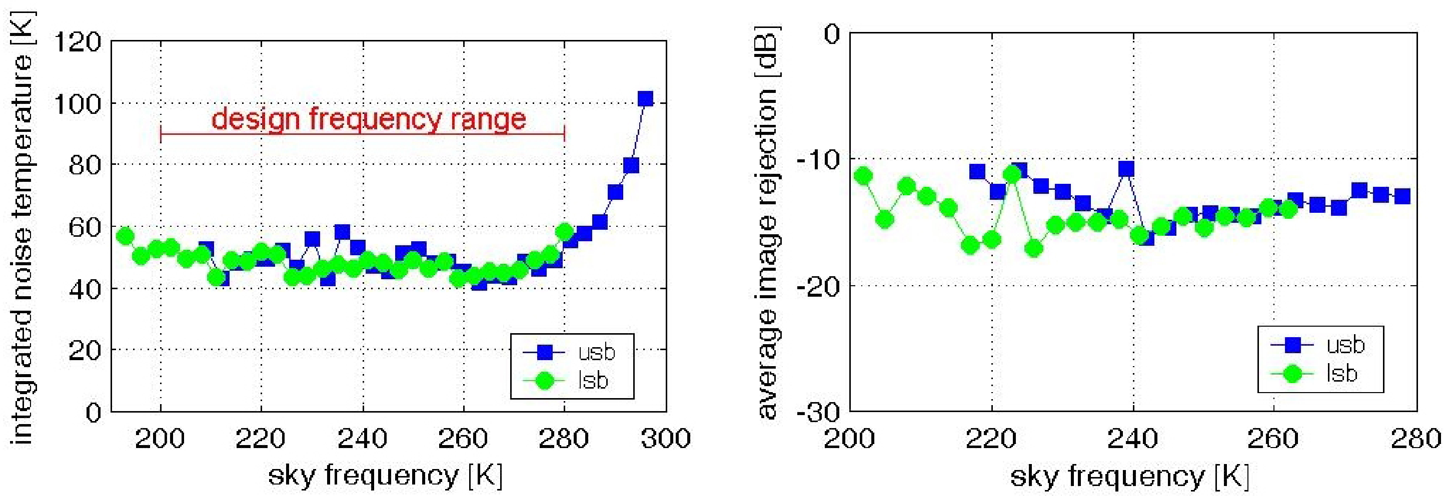
The follow-up project AMSTAR+ now allowed the development of a sideband-separating mixer for Band 3 covering the extended frequency range of 200–280 GHz. The new mixer delivers two IF outputs of 4–12 GHz, thus doubling the continuum sensitivity of the existing Band 3 receiver.

Prototype tests have shown that this new mixer obtains very good noise temperatures over the whole RF band (see figure left) with a flat response over the 4–12 GHz IF band. The average image rejection lies around 14 dB as can be seen in the right figure.

Further units of this mixer are currently produced and will be installed on-site during spring 2011.

Left: Noise temperatures integrated over the 4–12 GHz IF band.

Right: Image rejection averaged over the IF band.



Preparing GILDAS for large datasets

by Sébastien Bardeau, Emmanuel Reynier and Jérôme Pety

A new version of the GILDAS kernel was released beginning of February 2011 (feb11 version of GILDAS). The kernel was largely updated to use modern standards, e.g., multi-threading or the GTK+ toolkit. This allowed us to implement new facilities as a PNG output or an interactive lens, while keeping the backward compatibility whenever possible. New possibilities and changes are fully documented here http://www.iram-institute.org/medias/uploads/greg-2011.pdf.

These efforts were prompted by the tremendous increase of the size of the datasets produced by the IRAM instruments because of multi-beam receivers, wide bandwidth receivers, spectrometers with thousands of channels, and/or new observing modes like the interferometric on-the-fly.

Indeed, visualizing these datasets in a fluent way is a challenge that requires the best use of the available hardware and operating systems (multi-cores processors and multi-window environments).

After several years of work and several months of extensive tests inside IRAM/Grenoble, this version can be safely released as beta, i.e., we encourage our users to test it and to report any bugs to gildas@iram.fr. A standard release will happen in the coming months.

As a consequence, we do not support anymore older versions of the gildas kernel. Note that the dependencies of GILDAS changed: GILDAS now depends on the GTK+ toolkit and only recent versions of GFORTRAN and IFORT are supported (more details available on the supported systems section of the GILDAS web page at http://www.iram.fr/IRAMFR/GILDAS/).

News and Events

The IRAM Node of the European ALMA Regional Center

by Frédéric Gueth

The first Call for Proposal for the ALMA Early Science (16 antennas) operations will very certainly be issued in the first quarter of 2011. This obviously marks a critical milestone in the ALMA construction and deployment.

IRAM is one of the nodes of the European ALMA Regional Center (ARC). The ARCs are providing support to the ALMA scientific operations and the ARC nodes are more specifically in charge of helping the community in the preparation of ALMA observing proposals and in the data processing and analysis (including face-to-face support during visits at IRAM). The ARC node is a new service provided by IRAM, open to all interested scientists with special emphasis on the German, French, and Spanish communities.

The IRAM ARC node web pages already contain a series of practical information on ALMA Early Science and the support provided by IRAM. More details will be posted as soon as the first Call for Proposals will be issued.

7th IRAM Millimeter Interferometry School

by Frédéric Gueth

IRAM has organized last October its 7th millimeter interferometry school (which was co-funded by RadioNet).

65 participants from various countries attended this event, which proposed lectures on the basics of millimeter interferometry as well as on practical aspects (calibration, imaging). The important oversubscription shows the interest of the community for this school, which has been organized every two years since 1998. With the advent of ALMA and the start of the NOEMA project, we are looking forward to an even more interesting 8th school in 2012!

Lectures during the 7th IRAM millimeter interferometry school

Observing with ALMA: Early Science

by Frédéric Gueth

To prepare for the 1st ALMA Call for proposals, IRAM has organized a workshop from November 29th to December 1st.

More than 150 persons attended this meeting that took place in the Hotel Mercure in Grenoble. The presentations were essentially focused on practical aspects, such as the correlator modes, the imaging simulator, or the time allocation committee. Demos of the two most important softwares for the users (the Observing Tool and CASA) were also given.

The workshop web page provides now links to all presentations (pdf files).

Left: group photo of the ALMA Early Science Workshop.

Below: youngest participant of the workshop: Emilie Guilloteau-Dutrey.

News and Events

6th IRAM 30m Summerschool 2011 - Star formation near and far

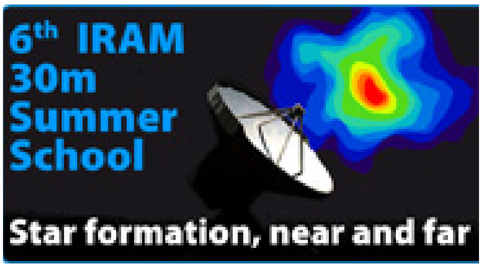
by Carsten Kramer

The 6th 30m summerschool "Star formation: near and far" will take place in the week of September 23 to 30 this year, in the ski resort Pradollano, in the Spanish Sierra Nevada, at only 15 minutes driving distance from the IRAM 30m telescope.

During the school, the participants will have the opportunity to use the telescope to observe star forming regions in nearby Galactic molecular clouds, in the Galactic Center, in nearby galaxies, and in distant galaxies at the edge of the observable universe. A team of 11 researchers will guide the observations and their reduction, interpretation, and presentation.

Moreover, they will give lectures on science topics they have been working on, using recent data from the IRAM observatories and other millimeter and far-infrared facilites.

These lectures will be complemented by dedicated lectures on millimeter instrumentation, observing techniques, and data processing software.



More information on the summerschool, the lectures, and the online registration form are found on the IRAM homepage.

Staff changes

Arrivals and Departures

Since the last edition of the IRAM Newsletter, there have been a number of new hires and departures.

At the headquarters in Saint Martin d'Hères, Jérémie Boissier left IRAM in order to take up a PhD position in the ESO ARC Node at Bologna. Pierre Gratier joined the IRAM Astronomy & Science Support Group at the beginning of the year. In the framework of SCHISM (Structure and Chemistry of the Interstellar Medium), a research project funded by the Agence Nationale de la Recherche, he will investigate the physics of a number of shocked interstellar gas regions with the Plateau de Bure interferometer and the 30m telescope.

Another member of the Astronomy & Science Support Group, Sascha Trippe, left IRAM at the end of February in order to take up a job as Assistant Professor at the Seoul National University in South Korea. On February, two visiting astronomers, Arturo Mignano and Simona Gallerani joined IRAM for a three and six-month internship. Both will be trained in millimeter-interferometry techniques.

Also on February, Irvin Still joined the Mechanical Group for a six-month internship as engineer.

In March, two new Post-docs arrived at IRAM: Chin-Shin Chang and Chiara Feruglio. Both will stay at IRAM for at least two years and strengthen the Science Operations Group of the Plateau de Bure interferometer.

Beginning of 2011, Clemens Thum has moved to Spain and IRAM/Granada. He continues as scheduler of the 30m telescope, but is available only in alternating weeks. In case of questions to the scheduler, please send a mail to scheduler30m@iram.es.

Regular visitor at the 30m telescope. Photo taken by Gregorio Galvez.

Rebeca Aladro has finished her PhD thesis on "Circumnuclear activity in galaxies and its influence on the physics and chemistry of the surrounding molecular gas". She defended her thesis at the Universidad de Granada on February 18th 2011, to start a PostDoc position at the University College London with Serena Viti in March.

Publications

from Sept. 2010 to Feb. 2011, compiled by Michael Bremer

Title	Authors	Reference
Shocked water in the Cepheus E protostellar outflow	Lefloch B., Cernicharo J., Pacheco S., Ceccarelli C.	2011, A&A 527, L3
Hunting for millimeter flares from magnetic reconnection in pre-main sequence spectroscopic binaries	Kóspál Á., Salter D. M., Hogerheijde M. R., Moór A., Blake G. A.	2011, A&A 527, A96
Molecular Gas in NUclei of GAlaxies (NUGA). XIV. The barred LINER/Seyfert 2 galaxy NGC 3627	Casasola V., Hunt L. K., Combes F., Garcìa-Burillo S., Neri R.	2011, A&A 527, A92
Different evolutionary stages in the massive star-forming region S255 complex	Wang Y., Beuther H., Bik A., Vasyunina T., Jiang Z., Puga E., Linz H., Rodón J. A., Henning T., Tamura M.	2011, A&A 527, A32

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Publications

Title	Authors	Reference
Water deuterium fractionation in the low-mass protostar NGC1333-IRAS2A	Liu F.-C., Parise B., Kristensen L., Visser R., van Dishoeck E. F., Güsten R.	2011, A&A 527, A19
Origins of the extragalactic background at 1 mm from a combined analysis of the AzTEC and MAMBO data in GOODS-N	Penner K., Pope A., Chapin E. L., Greve T. R., Bertoldi F., Brodwin M., Chary R.-R., Conselice C. J., Coppin K., Giavalisco M., Hughes D. H., Ivison R. J., Perera T., Scott D., Scott K., Wilson G.	2011, MNRAS 410, 2749
SiO outflows in high-mass star forming regions: A potential chemical clock?	López-Sepulcre A., Walmsley C. M., Cesaroni R., Codella C., Schuller F., Bronfman L., Carey S. J., Menten K. M., Molinari S., Noriega-Crespo A.	2011, A&A 526, L2
Mapping photodissociation and shocks in the vicinity of Sagittarius A*	Amo-Baladrón M. A., Martìn-Pintado J., Martìn S.	2011, A&A 526, A54
Weeds: a CLASS extension for the analysis of millimeter and sub-millimeter spectral surveys	Maret S., Hily-Blant P., Pety J., Bardeau S., Reynier E.	2011, A&A 526, A47
The properties of the interstellar medium within a star-forming galaxy at z = 2.3	Danielson A. L. R., Swinbank A. M., Smail I., Cox P., Edge A. C., Weiss A., Harris A. I., Baker A. J., De Breuck C., Geach J. E., Ivison R. J., Krips M., Lundgren A., Longmore S., Neri R., Flaquer B. O.	2011, MNRAS 410, 1687
Location of γ-ray Flare Emission in the Jet of the BL Lacertae Object OJ287 More than 14 pc from the Central Engine	Agudo I., Jorstad S. G., Marscher A. P., Larionov V. M., Gómez J. L., Lähteenmäki A., Gurwell M., Smith P. S., Wiesemeyer H., Thum C., Heidt J., Blinov D. A., D'Arcangelo F. D., Hagen-Thorn V. A., Morozova D. A., Nieppola E., Roca-Sogorb M., Schmidt G. D., Taylor B., Tornikoski M., Troitsky I. S.	2011, ApJ 726, L13
Dense Molecular Gas Excitation at High Redshift: Detection of HCO^+ (J = 4-3) Emission in the Cloverleaf Quasar	Riechers D. A., Walter F., Carilli C. L., Cox P., Weiss A., Bertoldi F., Menten K. M.	2011, ApJ 726, 50
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