iram info

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Word from the Director

Dear IRAM Newsletter Readers,

You will find hereafter the new issue of the IRAM Newsletter, which also includes the call for proposals for the winter semester 2010/2011.

Since the last issue, important enhancements have been made at the IRAM facilities. I would like to underline the successful commissioning of the new PdBI correlator, WideX, which is now fully operational and working within expectations.

Since March, many scientific results were obtained using WideX that would have been impossible or very difficult before. One such example includes the 3 mm spectrum of the Cloverleaf, which was obtained in only 3 hours and displays multiple molecular emission lines. It illustrates the powerful combination of WideX with the PdBI broadband receivers.

The Large Programs continue to be a success and this issue describes the results of a program that is studying the molecular gas content in galaxies at redshifts 1<z<3.

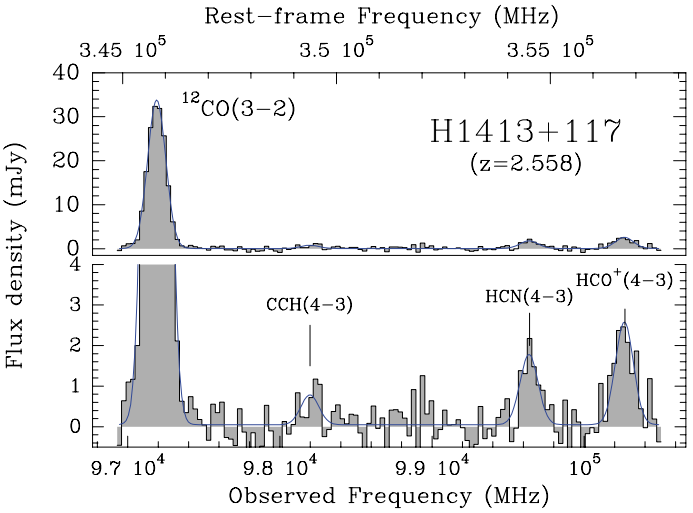
IRAM is pleased to host the 7th Interferometry School as well as the first workshop about ALMA Early Science that is organized by the IRAM ARC Node. These activities are important as they strengthen even further the links between IRAM and the astronomical community.

Pierre Cox

iram
Institut de Radioastronomie Millimétrique

High excitation lines of HCN and HCO^+ in the Cloverleaf quasar

by **Michel Guélin** on behalf of an **IRAM Grenoble & Granada team**



The Cloverleaf (H1413+117), the archetype of gravitationally lensed quasars, is one of the most luminous and best studied objects of the distant Universe. Its z=2.56 redshift places it 11 Gyr ago, in the era of peak quasar activity. Owing to strong magnification by a couple of interfering galaxies at z ~ 1.5, this broad absorption line QSO is by far the brightest CO source at high redshifts, hence one of the most favorable to study. The gravitational lens splits the QSO into 4 images, separated by z ~ 1", arranged as the leaves of a lucky clover.

Sub-arcsec resolution observations of the CO J=7-6 line with PdBI show the same pattern (Kneib et al. 1998). Modeling of the lens and source shows CO emission arises from a tilted disk 0.8 kpc in radius (Venturini & Solomon 2003). The physical conditions in the disk are however ill constrained from the sole CO data, even though all transitions between the J=3-2 and J=9-8 are detected (Bradford et al. 2009). This results from a near degeneracy between the kinetic temperature, T_k, and the gas density n_{H2} for a wide range of densities. To break the degeneracy, the analysis must be extended to high density probes, i.e. to

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7th IRAM Interferometry School

IRAM is organizing this year its 7th millimeter interferometry school, on October 4 - 8, 2010. The school is intended for PhD scientists who want to acquire a good knowledge of interferometry and data reduction techniques at millimeter wavelengths.

Read more about the interferometry school on page 11.

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Director Pierre Cox

Edited by Karin Zacher

Facilities

News from the Plateau de Bure Interferometer

by **Jan Martin Winters**

Antenna maintenance at the Plateau de Bure started this year on May 21, when antenna 1 was brought into the maintenance hall and the array entered into the 5D configuration.

It is foreseen to be completed in October 2010, when antenna 6 will leave the hangar with a newly equipped aluminum surface replacing the current carbon fiber panels.

WideX is operational

In February 2010, the remaining three units of the wide-band correlator WideX ("Wideband Express") were installed in the correlator room on Plateau de Bure and subsequently commissioned by a team of IRAM astronomers. Since March 15, WideX is routinely used for the observation of user programs. WideX provides a contiguous frequency coverage of 3.6GHz bandwidth in dual polarization with a fixed channel spacing of 1.95MHz and is available in parallel to the narrow-band correlator. Even if not needed to reach the science goals of a program, WideX greatly facilitates calibration and pointing of the interferometer and is therefore always connected. All information presently available on WideX can be found at http://www.iram.fr/IRAMFR/TA/backend/WideX.

Aluminum panels for antennas 1 and 6

Following the reflector upgrades of antennas 4 (2008) and 2 (2009), this summer the reflectors of the last two antennas, 1 and 6, will be equipped with aluminum panels. Work on antenna 1 has already finished on June 28, and antenna 6 will follow in September. Both reflectors will be tuned to a surface accuracy below 50μm rms by a series of holographic measurements and panel adjustments.

Installation of receiver band 4 and of the 3rd generation LO system

Band 4 mixers, covering the frequency range from 277 to 371GHz, will be installed this summer in the remaining 4 antennas (antennas 4 and 5 were already equipped last year). This installation is planned to be done during the maintenance of each antenna concerned, so no additional loss in observing time will result from this operation. Testing of the 350GHz mixers will however require some excellent observing conditions toward the end of the current summer semester. The installation of a new (3rd generation) LO system on Plateau de Bure, foreseen for the end of August and the first three weeks of September, will however require a shutdown of the interferometer for regular observations for at least one week. This new LO system will significantly reduce the instrumental phase noise, a necessary prerequisite for observations in the 0.8mm window.

Weather conditions and observing

Observing conditions this spring were quite mediocre from May onward with some small improvement only toward the end of June. Typical summer conditions are prevailing now on Bure with a very unstable

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Summer sunrise at the Plateau de Bure; Credit: Caroline Rose

atmosphere and often thunderstorms in the afternoons. Reasonable 3mm observing conditions are usually met only in the second half of the night and lasting until around noon.

We moved the array from its A configuration into the second most extended configuration B on February 21, 2010 and then C configuration was scheduled from March 21 to April 17, when the interferometer was moved back into the most compact D configuration.

The Bure interferometer participated in the global spring 3mm VLBI session from May 6 to 11 with the array observing in variable weather conditions. The 2010 antenna maintenance period started on May 21, when antenna 1 was brought into the maintenance hall and the array entered into the 5D configuration. The current antenna maintenance period is foreseen to end in October, when antenna 6 will leave the hangar with a newly equipped aluminum surface replacing the current carbon fiber panels.

Only two A-rated projects requesting the A-configuration and two requesting the B configuration could not be finished this year and will be deferred to the upcoming winter semester. As far as A-rated projects are concerned, we hope to bring most of these to completion before the end of the summer 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 of the current summer semester which are not started before the proposal deadline have to be resubmitted.

Global VLBI observations, which include the array in the 3mm phased-array mode, are planned from October 7 to 12, 2010.

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.

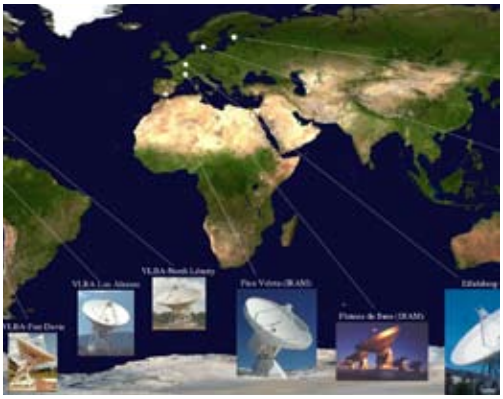
VLBI News

by Michael Bremer

Both IRAM instruments participated in the Global Millimeter VLBI Array (GMVA) session from May 6 - 11, 2010. At that time, the new WideX correlator was available on Plateau de Bure.

While the phased array operation for VLBI is exclusively reserved for the Bure narrowband correlator, WIDEX significantly increased the quality of pointing and focus estimates on weak sources.

Meteorological conditions were variable at both IRAM observatories, allowing only a part-time contribution to the global observing effort. At Pico Veleta, 52.7% of all scheduled scans could be observed, and Bure did 50.2% of all scans. The Bure percentage slightly improves to 53.8% when not counting scheduled sources within the Bure sun avoidance circle of 35º.

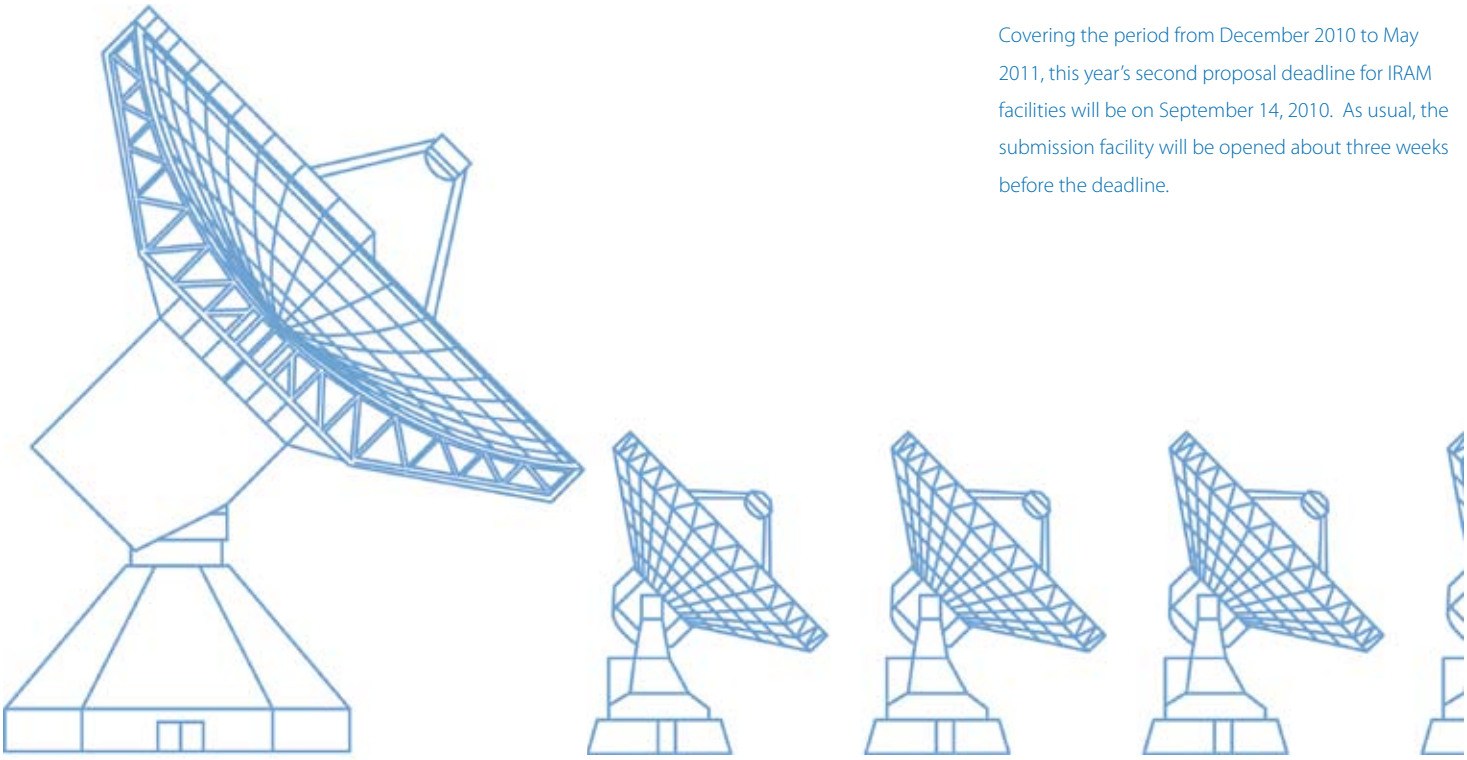


Both IRAM instruments took part in the Global Millimeter VLBI Array (GMVA) session form May 6 - 11, 2010.

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 December 2010 to May 2011, this year's second proposal deadline for IRAM facilities will be on September 14, 2010. As usual, the submission facility will be opened about three weeks before the deadline.

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

14 September 2010, 17:00 CEST (UT + 2 hours)

Please note that, departing from previous practice, the current deadline is on a Tuesday. The scheduling period extends from 01 December 2010 - 31 May 2011. Proposals should be submitted through our web-based submission facility. Instructions can be found on our web page at URL: 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 here.

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 or by
- 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 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 (see P. Cox in the last newsletter). The Large Programmes may have up to 4 pages for the scientific justification, plus cover page, the technical pages, and 2 pages for supporting

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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 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 (Cathy Berjaud). 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 winter semester (December 1, 2010 to May 31, 2011):

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

Emphasis will be put on observations at the shorter wavelengths, but 3mm proposals are also encouraged, particularly if they are suited for medium or low quality weather backup. The bulk of the observations at wavelengths ≤ 1.3 mm will be scheduled in pools which allow to optimize the observation queues according to weather conditions. During the last winter semester 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 preciptable water vapor drops below 2 mm 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.

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Facilities

With the upcoming winter semester, new Fast Fourier Transform Spectrometers (FTS) will be implemented and commissioned at the 30m telescope.

What is new?

Fourier Transform Spectrometers

The implementation and commissioning of the new Fast Fourier Transform Spectrometers (FTS) is proceeding as planned.

For the coming winter semester, two blocks of FTS will be available, each block covering a contiguous 4 GHz band. In this initial step, the spectral resolution of these FTS is fixed to 195 kHz. Assuming that further commissioning is successful, this new backend will be available for regular observations in all observing modes, except for polarimetry.

The new FTS backend provides a 16x larger bandwidth than VESPA at comparable resolution. Work is in progress, first, to increase the FTS bandwidth up to 32 GHz (at 195 kHz resolution) and, second, to provide higher spectral resolutions.

Time estimator

For proposal preparation, the new online time estimators for EMIR, HERA and MAMBO2 should be used (see the 30m homepage). Note that the estimators assume typical observation overheads, and give an estimate of the **total** observing times. For the heterodyne receivers, the noise estimate is done per beam, and not per observed grid position, as had been done with the previous estimator.

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/w10/w10.pdf.

Call for Observing Proposals on the Plateau de Bure Interferometer

by **Jan Martin Winters**

Conditions for the next winter session

Based on our experience in carrying out configuration changes in winter conditions with limited access to the observatory, we plan again to schedule four configuration changes during the upcoming winter semester. We therefore accept proposals for any of the 4 primary configurations of the six antenna array.

A preliminary configuration schedule for the winter period is outlined in the following. Adjustments to the provisional configuration planning will be made according to proposal pressure, weather conditions, availability of band 4, and other contingencies. The configuration schedule should be taken as a guideline, in particular when the requested astronomical targets cannot be observed during the entire winter period (sun avoidance circle of radius 35°).

We strongly encourage observers to submit proposals for the set of AB configurations that include the longest baselines. For these proposals we ask to focus on bright compact sources, possibly at high declination.

Conf	Scheduling Priority Winter 10/11
C	December
A	December - January
B	February - March
C	March - April
D	April - May

We invite proposers to submit proposals also for observations at 3mm. When the atmospheric conditions are not good enough at 1.3 mm or at 2 mm, 3 mm projects will be observed: in a typical winter, 20-30% of the time used for observations is found to be poor at 1.3mm, but still excellent at 3mm.

Receivers

All antennas are equipped with dual polarization receivers for the 3 mm, 2 mm, and 1.3 mm atmospheric windows, 0.8mm receivers are presently being installed. The frequency ranges are 80GHz to 116GHz for the 3 mm band, 129GHz to 174GHz for the 2 mm band, and 201 to 267GHz for the 1.3 mm band. The availability of band 4 (277 to 371GHz) can by no means be guaranteed presently. Any proposals submitted under this call for proposals and requesting observations in the 0.8mm window will be considered on a best effort basis only.

Local Contact

A local contact will be assigned to every A or B rated proposal which does not involve an in-house collaborator. He/she will assist you in the preparation of the observing procedures and provide help to reduce the data. Assistance (write to sog@iram.fr) is also provided before a deadline to help newcomers in the preparation of a proposal.

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Facilities

Depending upon the program complexity, IRAM may require an in-house collaborator instead of the normal local contact.

Technical pre-screening

All proposals will be reviewed for technical feasibility in parallel to being sent to the members of the program committee. Please help in this task by submitting technically precise proposals. Note that your proposal must be complete and exact: the source position and velocity, as well as the requested frequency setup must be correctly given.

Documentation

The documentation for the IRAM Plateau de Bure Interferometer includes documents of general interest to potential users and more specialized documents intended for observers on the site (IRAM on-duty astronomers, operators, or observers with non-standard programs). All documents can be retrieved on the Internet at http://www.iram.fr/IRAMFR/PDB/docu.html.

Note however, that not all the documentation on the web has already been updated with respect to the current receivers. All information presently available on the current receiver system is given in the Introduction to the IRAM Plateau de Bure Interferometer, in the call for proposals, and in the Calibration CookBook.

Publications

If your observations with the Plateau de Bure interferometer result in a publication, please acknowledge this in a footnote "Based on observations carried out with the IRAM Plateau de Bure Interferometer. IRAM is supported by INSU/CNRS (France), MPG (Germany) and IGN (Spain)". Please send a copy of the paper to Michael Bremer.

The complete text of the Call for Proposals can be retrieved from the IRAM web site at http://www.iram.fr/GENERAL/calls/w10/w10.pdf.

Scientific Results

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molecules with high dipole moments. The best molecules for that purpose are HCN and HCO^+, which are ubiquitous in dense clouds. Searches for HCN in the Cloverleaf started some 17 years ago with the IRAM 30m telescope and PdBI and more recently with the VLA. They led to the detection of a 6 mJy spectral feature tentatively assigned to HCN (4-3) by Barvainis et al. (1997) and to the detection of the J=1-0 HCN and HCO^+ lines (Solomon et al. 2003, Riechers et al. 2006); the HCN 4-3 detection was challenged by more sensitive PdBI data that set a twice lower 3 σ upper limit on this line.

One prerequisite for the detection of broad and weak lines is the accurate knowledge of the continuum level. Because the HCN and HCO^+ lines are nearly adjacent, a wide bandwidth is needed to simultaneously measure the weak 3-mm continuum and the molecular lines. The installation on the IRAM telescopes of wide-band receivers and backends, in particular WIDEX on PdBI and EMIR on the 30m telescope, allowed to resume the search.

The figure on page 1 shows the 3.6 GHz-wide PdBI spectrum obtained with WIDEX after 8 h of integration on source. The array was in the compact configuration, yielding a beam of 4.8" x 5.7", much larger than the source pattern. The spectrum was derived from point-source fits to the visibilities in the uv plane.

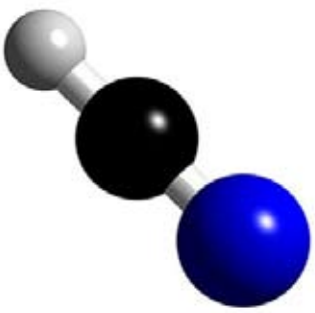
First, the line-free channels were fitted to determine the continuum flux, then, the continuum was subtracted from all visibilities. The r.m.s noise per 90 km/s channel is 0.35 mJy. The spectrum extends from 96.9 GHz to 100.5 GHz and covers the J=3-2 CO line and the J= 4-3 HCN, HCO^+ and CCH lines. The first 3 lines are observed with a high S/N ratio and the CCH line tentatively detected at 4 σ.

The first result of our study is that the HCN and HCO^+ line luminosities ($L' \sim \int S_v dv . \nu^{-2}$), decrease from J=1-0 to J=4-3 - which is not surprising, owing to the high critical densities of the 4-3 lines ($n_{crit} = 2 - 9 \times 10^6$ cm^{-3}). Those lines are not thermalized. The decrease, however, is not as large as expected.

The second result is that the L' (4 – 3) / L' (1 – 0) ratio is almost twice larger for HCO^+ than for HCN, which has the highest n_{crit}. The relative strength of HCO^+ (4-3) respect to HCN (4-3) seems to imply that collisions, rather than IR pumping, are the dominant excitation mechanism and that the gas density is very high in the molecular disc that surrounds the quasar.

The third result of our survey is that the 3-mm continuum is not negligible, contrary to what was assumed, so that that the luminosities of the previously detected 3-mm lines were overestimated.

The HCN molecule, a molecule which is known to be ubiquitous in dense clouds. Searches for HCN in the Cloverleaf started 17 years ago.



Scientific results

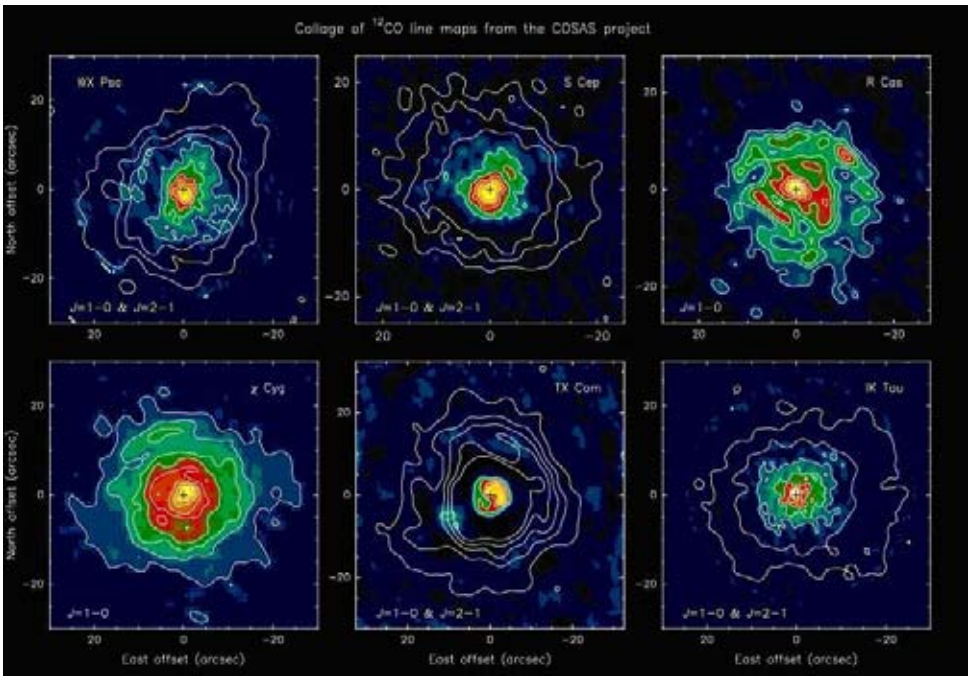
Mapping the ^{12}CO J=1-0 and J=2-1 emission in AGB and early post-AGB circumstellar envelopes

by **Arancha Castro-Carrizo** on behalf of the **COSAS collaboration**

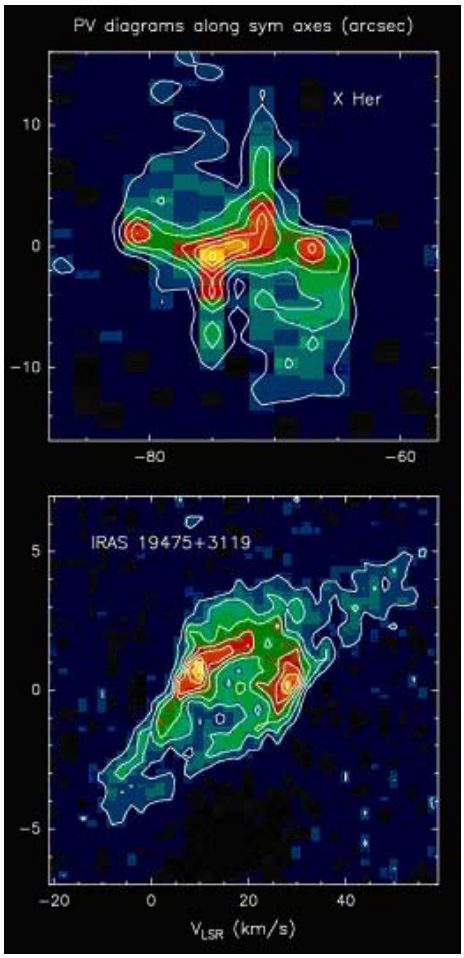
The late evolution of red giants at the end of the asymptotic giant branch (AGB) and the subsequent formation and shaping of a planetary nebula (PN) is the most spectacular change occurring in the life of evolved stars.

During this phase, the evolution of the star is no longer determined by nuclear reactions in the stellar interior, but is governed by the copious mass-loss taking place at the stellar surface. In the transition towards the post-AGB phase, episodic, fast winds emerge and interact with the envelope created in the AGB phase.

These wind interactions result in the complex morphology and dynamics of pre-PNe, forging the ultimate shape of PNe. Observations of low-excitation CO lines are known to provide the most reliable measurements of the main circumstellar properties (envelope mass, mass-loss rate, dynamical parameters, spatial extent, and shape) of AGB and early post-AGB sources.



Collage of the ^{12}CO J=1-0 and 2-1 line maps obtained at the systemic velocities for six sources out of sixteen within the first sub-sample of the COSAS program (accepted in June 10 by A&A).



Position-Velocity (PV) diagrams along the symmetry axes of two sources in the COSAS program.

In order to make progress toward a better understanding of the origin and evolution of the circumstellar envelopes around AGB stars, we have initiated COSAS (CO Survey of late AGB Stars), a systematic and deep survey of the molecular layout around late AGB stars. COSAS is a project to map and analyze the ^{12}CO J=1-0 and J=2-1 line emission in a representative sample of envelopes around late AGB and early post-AGB stars.

The survey was undertaken with the aim of investigating small- and large-scale morphological and kinematical properties of the molecular environment surrounding stars in the late AGB and early post-AGB phases.

For this, COSAS combines the high sensitivity and spatial resolving power of the IRAM Plateau de Bure interferometer with the better capability of the IRAM 30m telescope to map extended emission.

The global sample encompasses 45 stars selected to span a range in chemical type, variability type, evolutionary state, and initial mass. COSAS provides means to quantify variations in the mass-loss rates, assess morphological and kinematical features, and to investigate the appearance of fast aspherical winds in the early post-AGB phase.

The first of a series of COSAS papers presents the results from the analyses of a first sample of 16 selected sources. This work shows that the envelopes around these late AGB stars are mostly spherical, but often mingled with features such as concentric arcs (R Cas and TX Cam), a broken spiral density pattern (TX Cam), molecular patches testifying to aspherical mass-loss (WX Psc, IK Tau, V Cyg, and S Cep), and also with well-defined axisymmetric morphologies and kinematical patterns (X Her and RX Boo).

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The sources span a wide range of angular sizes, from relatively compact (CRL 2362, OH 104.9+2.4 and CRL 2477) to very large (χ Cyg and TX Cam) envelopes, sometimes partially obscured by self-absorption features, which in the case of IK Tau and χ Cyg testify to the emergence of aspherical winds in the innermost circumstellar regions.

Strong axial structures with more or less complex morphologies are detected in four early post-AGB stars (IRAS 20028+3910, IRAS 23321+6545, IRAS 19475+3119 and IRAS 21282+5050) of the first sub-sample.

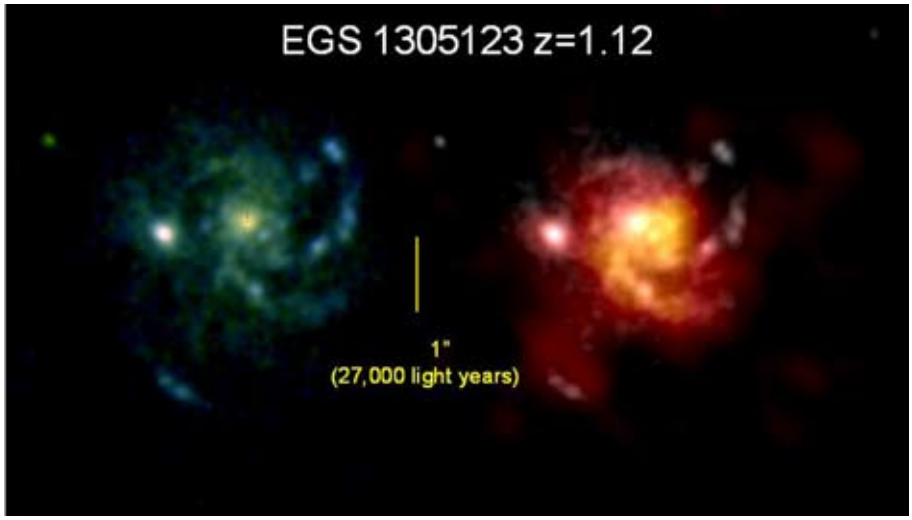
This project results from a large collaboration between IRAM (Castro-Carrizo, Neri, Quintana-Lacaci, Winters, Lucas, and Grewing), OSO (Olofsson, Schöier, and Lindqvist) and OAN (Bujarrabal and Alcolea) astronomers.

The data corresponding to this catalogue of AGB and post-AGB circumstellar envelopes will become available via the IRAM web in 2011, initially for the first published sub-sample.

Very High Gas Fractions in z=1-3 Star-Forming Galaxies

by **L. Tacconi, R. Genzel, P. Cox and the IRAM LP Team**

Observations of molecular gas in individual galaxies at high redshift are required to understand how galaxies have turned their gas into stars and how they have evolved as the Universe has aged. A direct assessment of this important component is essential to gauge any galaxy formation model. With this goal in mind, we were awarded an IRAM Large Program to complete the first systematic survey of CO emission of a moderately sized sample of 'typical' massive star forming galaxies (SFGs) at z >1. The program has been incredibly successful and exciting, and we report on some results here.



Spatially resolved optical and millimetre images of EGS 1305123, a typical massive galaxy at redshift z=1.12. The left image was taken with the Hubble Space Telescope in the V- and I-optical bands. The right image is an overlay of the CO 3-2 emission observed with the PdBI (red/yellow colours) superposed on the I-image (grey).

These observations clearly show that the molecular line emission and the optical light from massive stars trace a massive, rotating disk of diameter ~60,000 light years. This disk is similar in size and structure as seen in z~0 disk galaxies, such as the Milky Way.

To begin, we selected two samples of SFGs spanning similar ranges in stellar mass and star formation rates: one at z~1.2 and the other at z~2.3. The recent sensitivity improvements of the PdBI with the dual-polarization new generation receivers has given us the opportunity to sample the massive tail of typical star forming galaxy populations in these two redshift ranges. We are measuring the gas properties and dynamics in 15-20 galaxies at each redshift range through CO J=3-2 observations. We are also following up the brightest targets at high spatial resolution in the A-configuration to measure the first CO rotation curves of these sources.

We have published the first results (Tacconi et al. 2010, Nature, 463, 781), where we report on observation from 19 galaxies: 10 at z~2 and 9 at z~1. Six of the z~1 galaxies were already observed as part of a pilot program in the spring of 2008. We have detected CO in 14 of the galaxies at the 4σ or greater in integration times of 5-12 hours on source. In 5 galaxies the emission is either marginally or not detected, or may be continuum rather than line emission. The data reveal that SFGs are very gas rich, and that the star formation efficiency is not strongly dependent on cosmic epoch. The average fraction of cold gas relative to total galaxy baryonic mass at z = 2.3 and z = 1.2 is ~ 44% and 34%, respectively, three to ten times higher than in local spiral galaxies. A slow decrease from z≈2 and z≈1 likely requires semi-continuous replenishment of fresh gas to the young galaxies. Our survey is providing direct empirical evidence for the long-standing theoretical expectation that high-z SFGs are much more gas rich than z~0 galaxies, which probably explains many of their observed properties.

For EGS13035123 (z=1.12), EGS12007881 (z=1.17) and EGS13003805 (z=1.23) we obtained spatially resolved maps with FWHM resolutions of 0.6-1" (see figure above). Our CO map resolves for the first time the cold molecular gas distribution in a clearly non-merging high-z SFG, enabling a detailed investigation of

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Scientific results

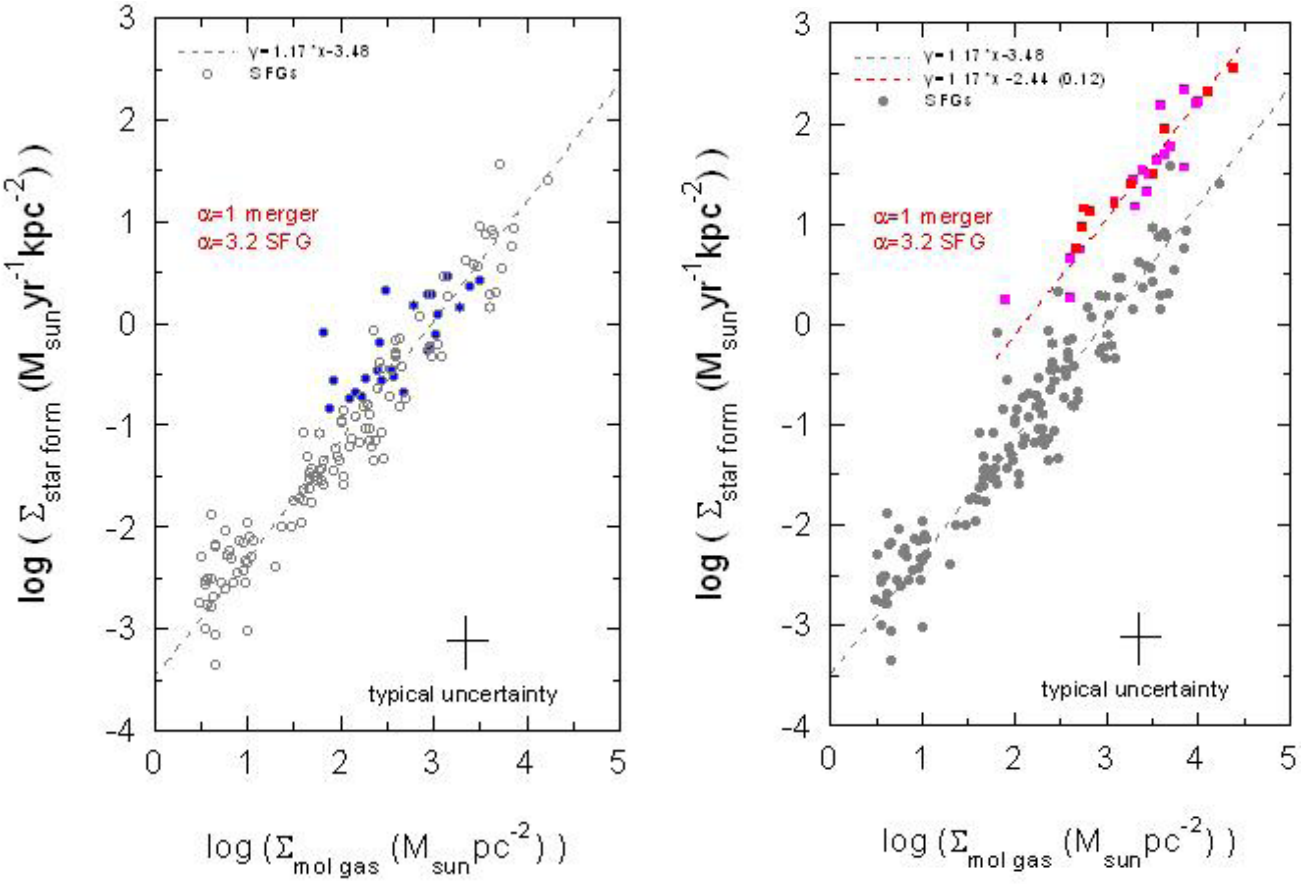
the cold gas kinematics. In the optical images EGS1305123 is a nearly face-on (inclination ~270), large (R1/2~9 kpc) spiral disk with a number of large star forming clusters. The clumpy CO emission extends over the entire galaxy disk but is somewhat more concentrated (R(CO)~6 kpc) than the rest-frame B-band stellar distribution, with a strong concentration of gas near the nucleus and innermost spiral arms.

Armed with these data and other data from the literature, we have analyzed the dependence of galaxy-averaged star formation rates on molecular gas masses at low and high redshifts, and in different galactic environments (Genzel et al. 2010, MNRAS, in press). Although the numbers of high redshift galaxies with molecular gas measurements are still small and biased towards the luminous and massive tail of the actively star-forming 'main-sequence', a fairly clear picture already emerges. Independent of whether galaxy-integrated quantities or surface densities are considered, low- and high-z SFG populations appear to follow similar molecular gas–star formation relations with slopes 1.1 to 1.2, over three orders of magnitude in gas mass or surface density (see figure below). The gas-depletion time-scale in these galaxies grows from 1 Gyr at z~2 to 1.5 Gyr at z~0. The average corresponds to a fairly low star formation efficiency of 2% per dynamical time. Because star formation depletion times are significantly smaller than the Hubble time at all redshifts sampled, star formation rates and gas fractions are set by the balance between gas accretion from the halo and stellar feedback. In contrast, very luminous and ultraluminous, gas-rich major mergers at both low and high z produce on average four to 10 times more far-infrared luminosity per unit gas mass.

Molecular surface density relations for star forming galaxies at low and high redshift.

Left panel: The $\Sigma_{molgas} - \Sigma_{starform}$ relation ('Kennicutt–Schmidt' relation) for "normal" star forming galaxies. Open grey circles denote SFGs at z~0 from the literature, and the filled blue circles are z=1-2.3 SFGs.

Right panel: The same molecular Kennicutt–Schmidt surface density relation for luminous z ~0 (KS) and z ~1–3.5 mergers (z ~0 LIRGs/ULIRGs: magenta squares, z ≥ 1submillimeter galaxies: red squares). The plot also shows their location in the KS plane together with the SFGs at all z (open grey circles) if the a priori best conversion factors for SFGs (α = αG) and mergers (α = αG/3.2) are chosen.



News and Events

Schools & workshops – autumn program

by **Frédéric Gueth**

7th Interferometry School

IRAM is organizing this year its 7th millimeter interferometry school, on October 4 - 8, 2010. It is intended for PhD scientists who want to acquire a good knowledge of interferometry and data reduction techniques at millimeter wavelengths. The program will include lectures on:

- Fundamentals of millimeter interferometry
- Atmospheric phase correction
- Data calibration and imaging techniques
- The IRAM Plateau de Bure interferometer
- The Atacama Large Millimeter/ submillimeter Array (ALMA)

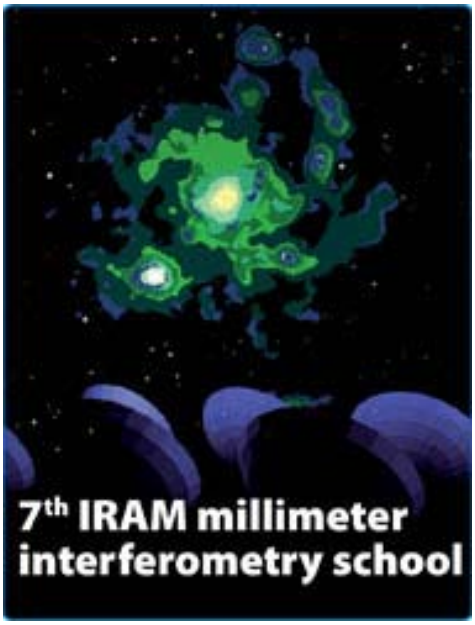
Tutorials will also be organized to help participants to become familiar with the reduction of Plateau de Bure data.

ALMA Early Science

The first call for proposal for the ALMA Early Science phase could be issued as early as the end of 2010. To help the IRAM community to prepare this important milestone, the IRAM node of the ALMA Regional Center will organize a practical workshop on how to plan and analyze ALMA Early Science observations, on November 29 - December 1, 2010.

A detailed, updated description of the ALMA Early Science capabilities will be presented: observing modes, correlator modes, system performances, calibration, etc. Practical points will be addressed, as e.g. the procedures to prepare and submit a proposal. The workshop will also include introduction and demonstration of key software for the ALMA users: the ALMA Observing Tool and the CASA off-line data reduction package.

Registration for this event is possible on the IRAM web pages. Interested participants are encouraged to register as soon as possible since a rapid over-subscription is to be expected.



Tutorials will be organized during the 7th IRAM interferometry school to help participants to become familiar with the reduction of Plateau de Bure data.

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, Abdelhakim Kassimi joined IRAM on February 1, 2010 for a six-month internship at the mechanical group in the frame of his engineering studies at the Université de Technologie de Compiègne. Since March 2010, Joelle Dague is in charge of the institute's missions and travel requests. She replaces Beatrice Maire who is on a maternity leave until September 2010. Also in March, Viviana Guzman Veloso (from Universidad de Chile) started a PhD work at IRAM in cooperation with the Ecole Normale Superieur. In May, Ivana Stoklasova from the University of Prague joined IRAM Grenoble for a two-month internship at the IRAM ARC Node. Alessandro Navarrini started his work as Head of the IRAM Frontend group on June 15, 2010. He replaces Bernard Lazareff who left IRAM in 2009 to work on optical interferometry at the Grenoble Observatory. Since the end of June, Nicolas Mourat replaces Stefan Marcoux at the general services who took a sabbatical year. After three years of parental leave, Magali Parioleau returned to the IRAM frontend group in July. Emilien Naffetat who had taken over her responsabilities, left IRAM in order to continue his studies.

In Granada, Breezy Ocana, finished her PhD thesis on "The interstellar medium in nearby elliptical radio galaxies" and successfully defended it at the Universidad de Granada. Jorge Abreu Vicente, who has just graduated at the Universidad de La Laguna on Tenerife, will become a new Astronomer of Duty and PhD student in August. End of July, Helmut Wiesemeyer will leave IRAM for a sabbatical year in the group of Karl Menten at the MPIfR in Bonn. Albrecht Sievers has taken over Helmut's work of maintaining and developing the calibration package mira and the online data processing, now preparing for the new high resolution Fast Fourier Transform Spectrometers.

At the Plateau de Bure, an additional operator, Erick Bondoux, and a new technician, Florentin Bard, were hired. The latter replaces Bernard Rossini who retired end of April after more than 25 years of activity at the interferometer.

Publications

IRAM related publication lists at ADS

by **Michael Bremer**

In each IRAM Newsletter and Annual Report publication lists are provided in order to give a sketch of the science done at IRAM and with IRAM instruments. Sometimes it could be useful to combine those lists with the multiple functionalities that the SAO/NASA Astrophysical Data System (ADS) provides.

To this effect, the IRAM publication lists since the year 2000 have been entered as private libraries into the ADS system. A page with links is available on the IRAM web pages in the "Science Users", "Letters, results and reports" pages. A direct link is provided here. Although ADS provides an extensive scope of bibliographic sources, not all references of the Annual Report lists are available. The electronic lists are therefore less complete than the printed ones.

But even so the ADS private libraries contain the high impact papers that show where IRAM helped to advance astronomy. Such papers can now easily be identified with the citation counts that ADS continuously updates, and for which the lists can be sorted. IRAM plans to extend the electronic lists to years before 2000.

from March 2010 to August 2010, compiled by Michael Bremer

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Constraining the Cold Gas and Dust in Cluster Cooling Flows	O'Dea C. P., Edge A., Hamer S., Fabian A., Johnstone R., Crawford C., Oonk R., Jaffe W., Hatch N., Baum S., Mittal R., Quillen A., Wilman R., Wise M., McNamara B., Bremer M., Combes F., Salome P., Boehringer H., Popesso P., Sarazin C. L., Allen S., Egami E., Donahue M., Voit M., Bregman J., Ferland G.	2010, AAS 41, 398
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