IRAM Newsletter

Number 29 December 16, 1996

Calendar

March 3rd, 1997: Deadline for the submission of observing proposals for the period May 15, 1997 to Nov. 15, 1997.

15-17 April 1997: "The Far InfraRed and Submillimetre Universe", An ESA Symposium devoted to the Far InfraRed and Submillimetre Telescope (FIRST) cornerstone mission. IRAM will be responsible for the local organisation.

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30m Telescope

Winter conditions soon expected at Pico Veleta

The telescope was cut off from the outside already twice this autumn. Heavy snowfalls during a few days in September and October stopped the observations and caused some transport problems, but the road was cleared, and the snow soon melted away. However, it soon may snow again, and the transport to the telescope will then be done by ratrack. This may result in some inconvenience since the cable car may not work yet in November, and the trip by ratrack may be longer than usual. We therefore would like to ask visiting astronomers to the 30m telescope to plan their trips with enough margin to account for delayed transport to and from the telescope.

Below you find the schedule for the normal winter transport, i.e. when the cable car is operating. During the transition period (i.e. with snow, but without cable car), the transport has to be organized in a very flexible way.

Transport to the 30m Telescope: Winter 1996/97 schedule (subject to modification on short notice due to operational reasons)

	Departure from Granada Office	Departure from the Telescope
Monday	08:15	10:45
Tuesday	08:15	10:45 and 16:15
Wednesday	No transport*	No transport*
Thursday	10:00	16:15
Friday	08:15	10:45 and 16:15

* Person transport (morning hours) may be available only after contact and agreement with IRAM-Granada (Javier Lobato).

Receiver news

A stability problem of the 1.3 mm receiver G2 – manifesting itself in poor baselines – could be solved by replacing the cold HEMT amplifier.

Lately, the 1.3 mm receiver G1 occasionally showed a broad feature (about 80 MHz wide) in the baseline. This feature occurs erratically and can severely degrade the spectrum. However, most of the time the baseline is ok. The cause for this feature is not known at this point. The problem is being investigated.

Additional flights to Granada

Up to now there were only a few flight connections to Granada. The Spanish company AVIACO usually offers two to three flights daily, connecting Granada with Madrid and Barcelona typically in the morning and evening. This limited offer sometimes made it difficult to travel to Granada without long stopovers. An alternative used by many visitors to the 30m telescope was a flight to Malaga.

Two additional airlines have now announced direct flights from and to Granada from various destinations in Spain and Europe. Starting November 1^{st}, the Spanish airline Air Europa will offer 19 flights per week connecting Granada with a number of cities throughout Spain and Europe. Additional flights to Barcelona and Madrid (the latter ones starting at a later date, however) will be available. From November 7^{th}, the German company LTU will offer a direct flight Düsseldorf – Granada once a week on Thursdays. Please contact your travel agent for details about these new flights.

New Bus Station in Granada

Beginning of November, the new bus station of Granada was inaugurated. Buses coming from (and going to) Malaga – and other destinations in Andalucia – will arrive at the new bus station which is located in the western part of Granada (near the shopping center "Al Campo") and thus further away from the IRAM office than the old bus station. Visiting astronomers can either take a bus (line no. 3) or a taxi to get to the IRAM office and residencia (get off at the bus stop "Triunfo Jardin"). Walking would probably take approximately 30 minutes.

Internet in Spain

Don't always rely on the Internet !

Despite the improvements both in speed and reliability of our Internet connection during the past years, we would like to urge observers NOT to rely on the Internet for transferring files necessary to carry out the observations (e.g. source list, frequencies, previous data etc.). Although disruptions have been scarce lately, it still can be the case that no Internet access is possible for (short) periods of time (according to Murphy's law, this of course happens when a connection is desperately needed...). Unfortunately, there is no guarantee for Internet availability. Interruptions usually occur due to causes which are outside IRAM's responsibility (and "sphere of influence").

We therefore strongly advise Visiting Astronomers to the 30m telescope to either transfer their files *before* they come to the telescope (e.g. to the `visitor` account in Granada), or bring them on a DAT. Not all computers at IRAM Granada (downtown and telescope) are accessible from outside by ftp because of security considerations. Please contact Walter Brunswig (`brunswig@iram.es`) in case of problems.

Wolfgang WILD

Interferometer

The interferometer is now fully operational with 5 antennas.

To improve the efficiency of operations after snowfalls, and in particular to allow easier access to the longest baselines, a new "Ratrack" has been bought and delivered to the site. This should significantly speed up the snow cleaning and improve access to the antennas under poor weather conditions.

Stéphane GUILLOTEAU

Program Committee News

30m-Telescope

A Programs			B Programs		C Programs		
134.96	185.96	243.96	132.96	239.96	130.96	195.96	252.96
141.96	190.96	248.96	133.96	244.96	131.96	201.96	255.96
142.96	192.96	250.96	136.96	251.96	135.96	202.96	258.96
144.96	197.96	254.96	139.96	253.96	137.96	203.96	259.96
145.96	198.96		140.96	256.96	138.96	207.96	
151.96	199.96		150.96	257.96	143.96	210.96	
152.96	200.96		164.96	260.96	146.96	211.96	
153.96	208.96		167.96	261.96	147.96	213.96	
154.96	209.96		170.96		148.96	215.96	
155.96	212.96		171.96		149.96	220.96	
156.96	214.96		178.96		157.96	224.96	
158.96	216.96		181.96		159.96	225.96	
162.96	217.96		189.96		160.96	227.96	
163.96	219.96		191.96		161.96	228.96	
165.96	221.96		194.96		166.96	230.96	
168.96	222.96		196.96		172.96	232.96	
169.96	223.96		204.96		174.96	236.96	
173.96	226.96		205.96		176.96	241.96	
175.96	229.96		206.96		179.96	242.96	
177.96	231.96		218.96		182.96	245.96	
180.96	234.96		233.96		186.96	246.96	
183.96	238.96		235.96		188.96	247.96	
184.96	240.96		237.96		193.96	249.96	

Notes: 262/263.96 are late proposals, deferred to the next session; 187.96 : Technical program.
We expect all A programs to be scheduled on the 30-m telescope although some with less time than originally requested. Only part of the B programs will be scheduled. This will take into account scientific merit, crowding in certain right ascension ranges and general aspects of balance.

Michel GUÉLIN

Interferometer

Project	Rate	Project	Rate	Project	Rate	Project	Rate	Project	Rate
G003	B	G007	B	G020	C	G023	B	G031	C
G037	A	G040	B	G041	B	G042	B	G043	A
G044	C	G045	A	G046	B	G047	C	G048	A
G049	A	G050	A	G051	C	G052	B	G053	A
G054	A	G055	B	G056	A	G057	B	G058	A
G059	B	G060	C	G061	C	G062	B	G063	A
G064	A	G065	B	G066	C	G067	A	G068	C
G069	A	G070	A	G071	B	G072	C	G073	A
G074	A	G075	B	G078	B	G079	A	G080	A
G081	C	G082	A	G083	A	G084	B	G085	B
G086	C	G087	C	G088	C	G089	B	G090	C
G091	C	G092	A	G093	A	G094	A	G095	A
G096	C	G097	B	G098	A	G099	A	G100	C
G101	C	G102	B	G103	A				

Project Status: A: Accepted, B: Backup if available time, C: Rejected.

The relatively large number of B proposals is related in part to our insufficient experience with the 5 antennas system, and also to the very significant number of long baseline projects.

Stéphane GUILLOTEAU

Scientific results

The Molecular Interstellar Medium in Ultraluminous Infrared Galaxies

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Abstract: We present observations with the IRAM 30 m telescope of CO in a large sample of ultraluminous IR galaxies out to redshift $z = 0.3$. Most of the ultraluminous galaxies in this sample are interacting, but not completed mergers. The CO(1–0) luminosity of all but one of the ultraluminous galaxies is high, with values of $log(L'_{\rm CO}/{\rm K\ km\,s^{-1}\ pc^2}) = 9.92 \pm 0.12$. The extremely small dispersion of only 30 % is less than that of the far infrared luminosity. The integrated CO line intensity is strongly correlated with the 100μm flux density, as expected for a black body model in which the mid and far IR radiation is optically thick. We use this model to derive sizes of the FIR and CO emitting regions and the enclosed dynamical masses. Both the IR and CO emission originate in regions a few hundred parsecs in radius. The median value of $L_{\rm FIR}/L'_{\rm CO} = 160\ {\rm M_\odot/K\ km\,s^{-1}\ pc^2}$, within a factor of two or three of the black body limit for the observed far IR temperatures. The entire ISM is a scaled up version of a normal galactic disk with the ambient densities a factor of 100 higher, making even the intercloud medium a molecular region. We compare three different techniques of H_2 mass estimation and conclude that the ratio of gas mass to CO luminosity is about a factor of four times lower than for Galactic molecular clouds, but that the gas mass is a large fraction of the dynamical mass. Our analysis of CO emission from ultraluminous galaxies reduces the H_2mass from previous estimates of $2 - 5 \times 10^{10}{\rm M_\odot}$ to $0.4 - 1.5 \times 10^{10}{\rm M_\odot}$, which is in the range found for molecular gas rich spiral galaxies. A collision involving a molecular gas rich spiral could lead to an ultraluminous galaxy powered by central star bursts triggered by the compression of infalling preexisting GMC's.

The extremely dense molecular gas in the center of an ultraluminous galaxy is an ideal stellar nursery for a huge star burst.

CO observations and a new interpretation of the anomalous arms of NGC 4258

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Abstract: We present CO(2–1) maps of the molecular gas associated with the inner parts of the anomalous arms of NGC 4258. The CO emission is found to be well correlated with the arms and extends out to about 2 kpc from the center. Together with CO(1–0) and (3–2) measurements and the detection of ^{13}CO(1–0) and CS(3–2) toward the center of NGC 4528, we derive the physical conditions of the molecular gas along these arms and analyse in detail the dynamics of the gas. The molecular gas is relatively dense (10^3 cm^{-3} on average) and warm (50 to 100 K) with a total H_2 mass of 10^9 ${\rm M_\odot}$. The CO distribution shows a characteristic S-shaped morphology along which the molecular gas is found to move *toward* the nucleus, not away from it.

Contrary to previous interpretations, we suggest that the anomalous arms in NGC 4258 trace the gas flow due to a bar rather than being the manifestation of a jet. Both the S-shaped morphology and the velocity dispersion revealed by the present CO measurements are characteristic of barred galaxies. In the bar of NGC 4258 most of the gas is molecular, not atomic. The molecular gas is bounded by the sharp leading edge traced in the radio continuum that is probably the bar shock with its compressed magnetic field. The shocked Hα emission along the anomalous arms is probably a secondary manifestation of the bar shock. In the X-ray emitting gas associated with the anomalous arms, the temperature is consistent with velocities and densities in bar shock fronts rather than in jets of radio galaxies. We suggest that the X-rays, like the radio continuum and optical line emission, are produced via the bar shock, and are unrelated to a jet from the black hole. The large extension of both the Hα and radio emissions out to a projected distance of $\sim$ 7 kpc probably trace the hot (10^6 K) thermal X-ray gas produced by the bar shocks which leaks out of the bar structure and eventually escapes from the disk in the z direction. We predict that with sufficient sensitivity and angular resolution, similar radio and X-ray emission will also be found in the shock fronts of other, more distant, barred galaxies.

The molecular envelope around T Tauri and the nature of NGC1555

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([3]) Five College Astronomy Department; and Department of Physics and Astronomy, University of Massachusetts
([4]) Royal Observatory, Blackford Hill, Edinburgh EH9 3HJ, Great Britain
([5]) Visiting Astronomer at the James Clerk Maxwell Telescope

Abstract:

We present maps of the ^{12}CO(3–2) and C^{18}O(2–1) emission around T Tauri. By comparison of the two lines measured with similar spatial resolution we are able to discriminate between the different components of molecular circumstellar material and to derive constraints for possible source models. In particular we are able to trace the outflowing molecular components. We propose a multiple outflow system with stellar wind envelope interaction to explain the morphology and dynamics of the ^{12}CO(3–2) and C^{18}O(2–1) emitting gas.
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A high-resolution ^{12}CO(1-0) study of the nucleus of NGC 5907– Observations and modelling

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Abstract: We have studied with the IRAM interferometer the ^{12}CO(1–0) emission around the nucleus of NGC 5907, an edge-on spiral at the center of which we had previously detected fast rotating molecular gas. The high angular resolution (3.1$''$, or 160 pc along the major axis) allowed an accurate determination of NGC 5907's kinematical center ($\alpha(J1950.0) = 15^h14^m35.5^s$, $\delta(J1950.0) = 56^o30^{'}43.3^{''}$).

Within $\pm 2''$ from the center, we detect molecular gas with velocities of ± 160 kms^{-1} (relative to the source systemic velocity $V_{sys} = 677$ kms^{-1}(LSR)), and, within $\pm 10''$ from the center, velocities of up to ± 180 km/s. Part of the gas exhibits non-circular motions. We explain the gas kinematics by the presence of a stellar bar with an angular velocity (Ω_p=70 kmskpc^{-1}) and of an Outer Inner Linblad Resonance (oILR) at r$\simeq$ 14". The dynamical mass inside the $R < 300$ pc region, estimated from the steepness of the apparent rotation curve, is $\simeq 5\ 10^9 M_\odot$. It is comparable to the stellar mass derived from near IR photometry and > 10 times larger than the mass of gas in the same region. The CO brightness distribution and, presumably, the molecular gas distribution are highly asymmetrical.

The interferometer, which filters out the smooth disk emission detected by the 30-m telescope, reveals two narrow structures parallel to the major axis. We identify those with spiral arms. From their position and velocities, we determine an inclination $i = 86.5°$ of the plane of the galaxy. The thickness of the arms, perpendicularly to this plane, is found to be $\leq 3''$ ($\leq$150 pc).

The large mass concentration near the nucleus and the flat rotation curve of NGC 5907 are more typical of early or intermediate-type spirals than of late type spirals. Yet, the large CO and HI luminosties, the conspicuous molecular arms, and the absence of visible bulge on optical photographs are more characteristic of Sc-Sd galaxies. NGC 5907 may thus be at a critical stage of galactic evolution.

Molecular gas in the warped galaxy NGC 4013

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Abstract: The edge-on spiral galaxy NGC4013 has been mapped in the J=2–1 and 1–0 lines of ^{12}CO with the IRAM 30m telescope (HPBW 13" and 21"). CO emission is detected within a galactocentric radius, $R \sim 100$" (5.5 Kpc). The radial molecular gas distribution consists of ring-like source (of radius r$_{ring}$ $\sim$ 1.5 kpc), and a fast rotating nuclear disk (of radius r$_{nucl}$ $\sim$ 500 pc).

The CO velocity field, derived from the position-velocity diagram taken along the galaxy major axis, reveals the existence of a compact nuclear disk rotating at high velocities which has no HI counterpart. The derived rotation curve reaches v$_{rot}$ $\sim$ 130 kms^{-1} in less than $r \sim$ 250 pc. This high velocity regime for molecular gas is satisfactorily explained by an inner bar scenario. The bulge of NGC4013 is box-shaped at optical wavelengths, which suggests the existence of a non-axisymmetric potential in the inner disk. The distribution of CO emissivity itself towards the center suggests that the orbits of some molecular clouds are inclined with respect to the plane of the galaxy.

NGC4013 presents a distorted vertical distribution of matter (stars and gas): it has a box-shaped bulge, a thick optical disk with a warped plane, and a spectacular HI warp in the outer disk. The molecular gas disk vertical structure is not resolved in the 2–1 line. The slight inclination of the galaxy allows us detecting non-axisymmetric

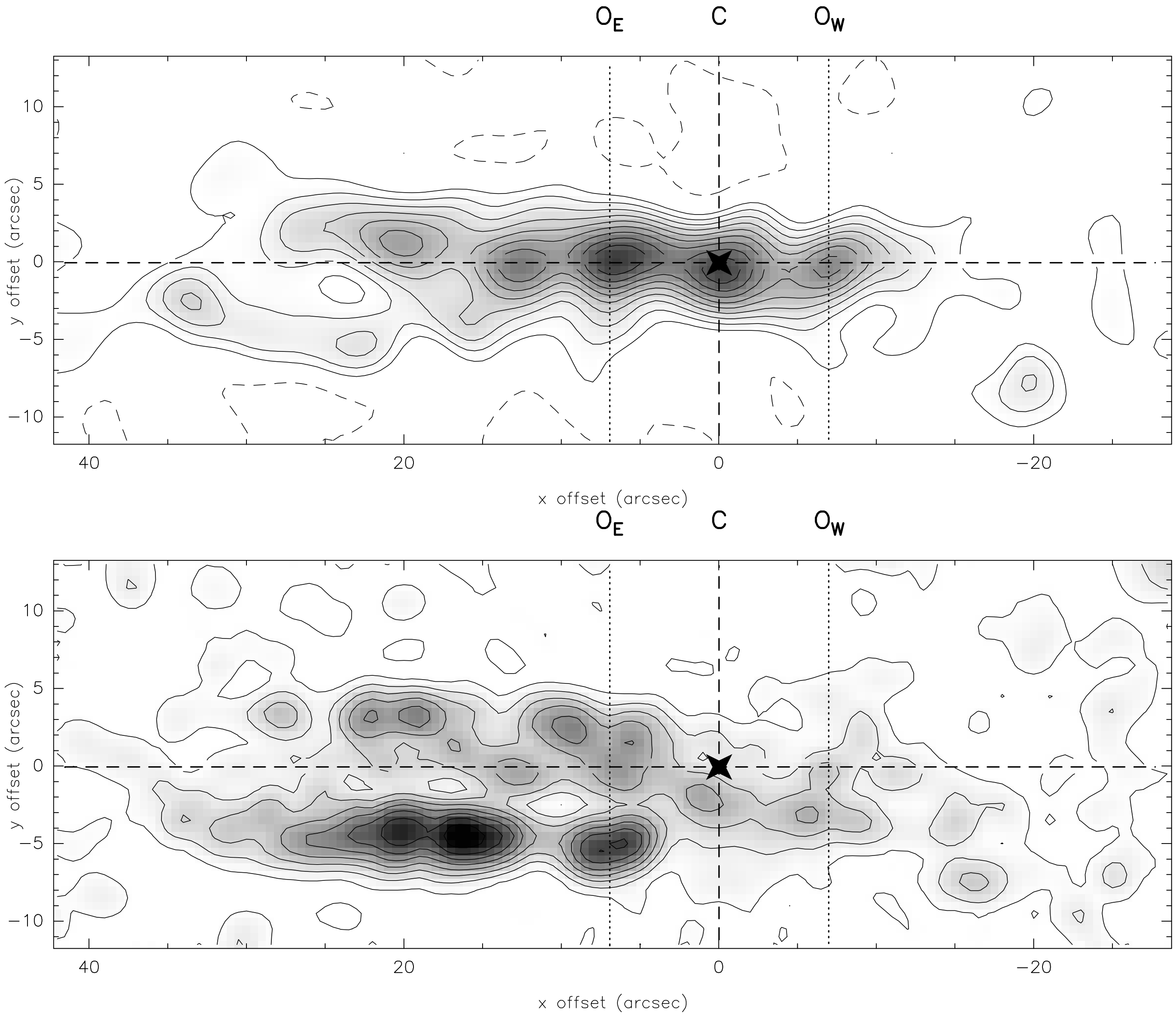

Figure 1: **a)**(top): ^{12}CO(1–0) integrated intensity contours observed with the Bure interferometer towards the center of NGC 5907. x and y are offsets (in arcsec) with respect to the dynamical center **C**. Contours are -2 Jy.kms^{-1} per 3.6$''$ beam and 1 to 9 Jy.kms^{-1}beam^{-1}, by steps of 1 Jy.kms^{-1}beam^{-1}. The maximum is I$_{max}$= 9.4Jy kms^{-1}beam^{-1}). **b)**(bottom):^{12}CO(1–0) peak brigthness temperature contours. Contours correspond to 10%, 20%.. 90% of the peak maximum of (0.17 Jy.beam^{-1}). The dashed $y = 0$ line represents the major axis and the dashed $x = 0$ line, the minor axis. The central bar, projected on the plane of the sky, lies between $\mathbf{O}_E$ and $\mathbf{O}_W$.

structures that are probably spiral arms. If so the estimated inclination angle is i=86.°5, in excellent agreement with the derived by Guthrie (1992) from optical data. We show that the warp of the stellar disk reported from optical measurements might be an artifact due to spiral arms seen in projection. We have not detected a CO counterpart of the HI warp.

Successive SiO shocks along the L 1448 jet axis

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Abstract: We present a complete SiO $v = 0, J = 2 \rightarrow 1$ synthesis image of the red-shifted outflow lobe from the Class 0 protostar L 1448-mm. The image is a 5-field mosaic obtained with the IRAM interferometer at $\sim 3''$ angular resolution. The SiO emission arises in a highly-collimated jet extending over 0.2 pc. The jet consists of four main blobs, probably corresponding to successive episodes of mass-loss from the central object. The kinematical structure of the jet is studied by the means of velocity channel maps and position-velocity diagrams, and is compared to current models of jet-driven bipolar outflows. We have constructed a kinematical model of bow-shock to make such comparison as detailed as possible. We find that most of the SiO clumps delineate partial bow-shock structures, but important SiO emission is also seen along the jet axis itself. Shock-processing of the dust grains, and perhaps chemical gas-phase reactions in the protostellar wind and in the mixing layer, could explain the enhancement of SiO in the different jet blobs. The CO outflow in L 1448, and perhaps in all bipolar outflows, is thought to be driven by a primary jet ejected from the central star/disk system. We conclude that, if not the primary wind itself, the material traced by the SiO emission reported here is very closely linked to this primary jet.

New Preprints

415. Shocks and ring in the barred spiral galaxy NGC 1530
D. Reynaud, D. Downes
1996, *Astronomy and Astrophysics*

416. A high-resolution $^{12}CO(1$–$0)$ study of the nucleus of NGC 5907
S. Garcia-Burillo, M. Guélin, N. Neininger
1996, *Astronomy and Astrophysics*

417. The molecular interstellar medium in ultraluminous infrared galaxies
P.M. Solomon, D. Downes, S.J.E. Radford, J.W. Barrett
1996, *Astrophys. Journal*

418. The molecular envelope around T Tauri and the nature of NGC 1555
K.-F. Schuster, A.I. Harris, A.P.G. Russell
1996, *Astronomy and Astrophysics*

419. Thermal methanol emission in the DR21 complex interferometric maps: A comparison with maser emission
S. Liechti, C.M. Walmsley
1996, *Astronomy and Astrophysics*

420. Detection of a new linear carbon chain radical: C_7H
M. Guélin, J. Cernicharo, M.J. Travers, M.C. McCarthy, C.A. Gottlieb, P. Thaddeus, M. Ohishi, S. Saito, S. Yamamoto
1996, *Astronomy and Astrophysics*

421. Molecular gas in the warped galaxy NGC 4013
Ana I. Gómez de Castro, S. García-Burillo
1996, *Astronomy and Astrophysics*

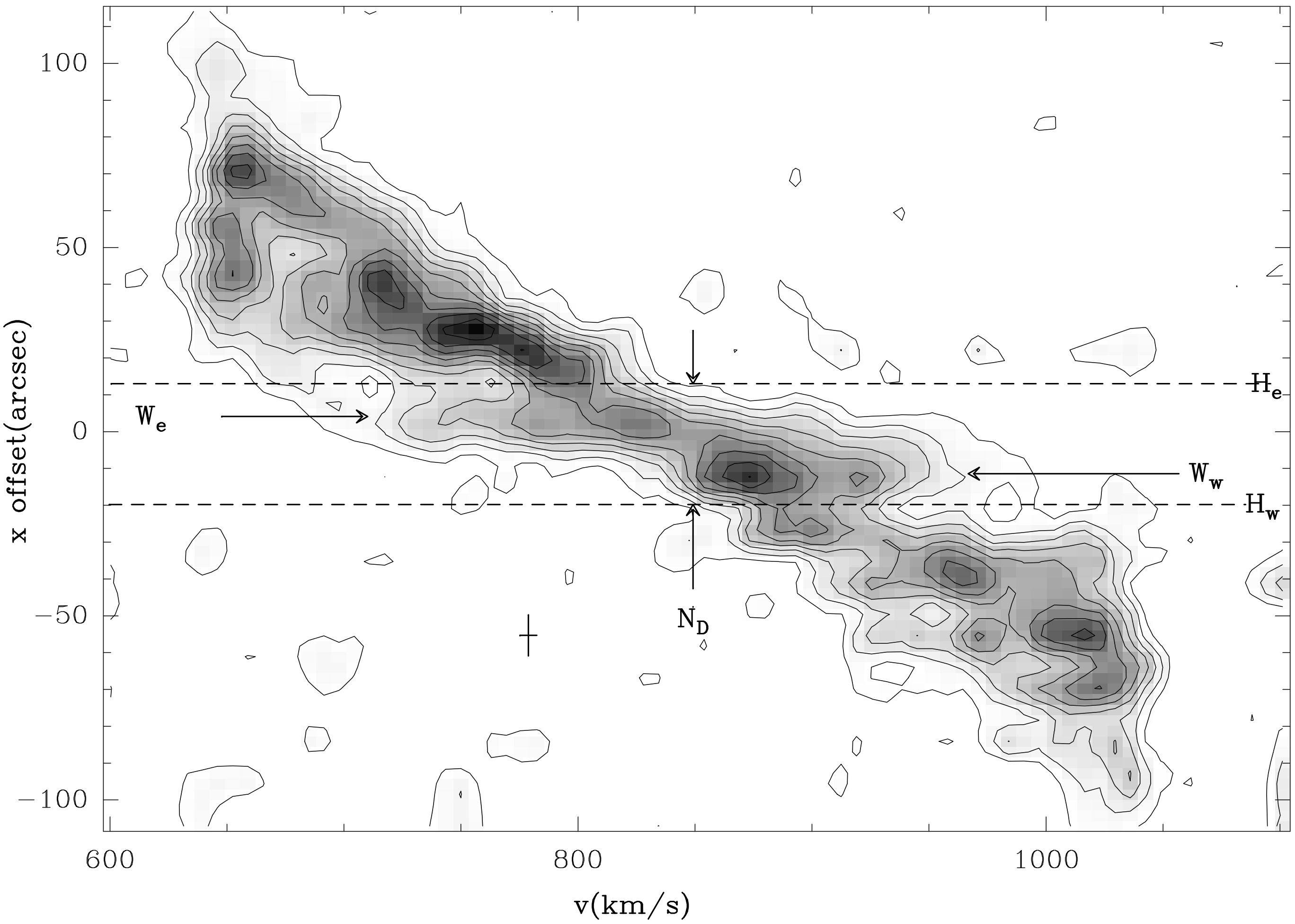

Figure 2: Position-velocity diagram, observed along the kinematical major axis of NGC4013, in the $^{12}CO(2–1)$ line (solid contours and grey scale). The location of the nuclear disk (**ND**), the high velocity gas ($\mathbf{W}_e$ and $\mathbf{W}_w$) and the CO depleted regions ($\mathbf{H}_e$ and $\mathbf{H}_w$) are indicated by the arrows. Countour levels and gray scale are equally spaced from 10% to 90% by steps of 10% of the maximum value (0.075 K). The cross in the bottom left quarter indicates the resolution in both axis (6.5 km s^{-1}, 12")

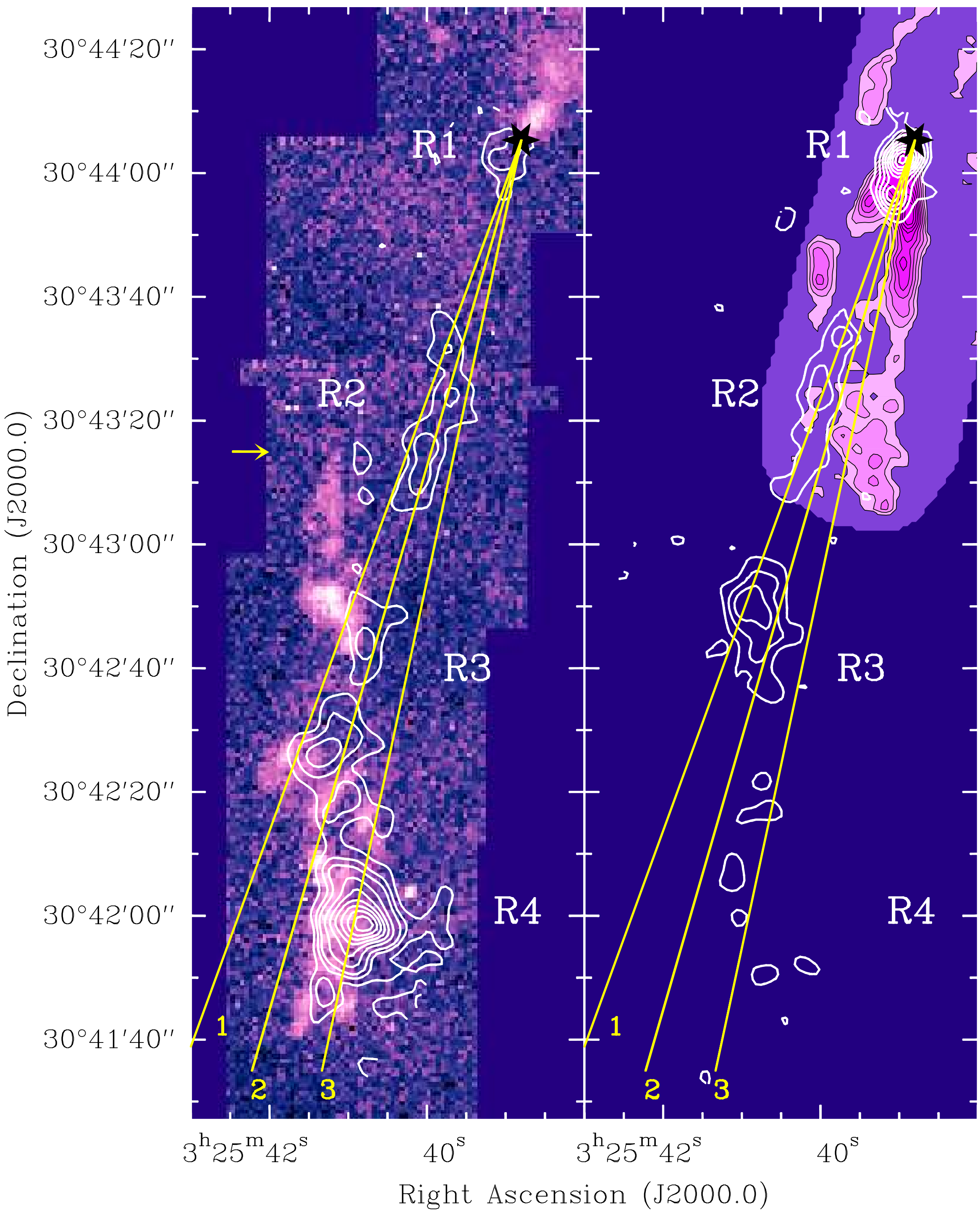

Figure 3: SiO contour maps overlaid on the H_2 emission (left), and CO J=1-0 integrated intensity (right). The arrow shows the global shift (6″) of the H_2 emission from the nominal position given by Bally et al. (1993, ApJ 418, 332), who mentioned positional errors of 5″. The area covered by the CO image (Bachiller et al., 1995, A&A 299, 857) is indicated by the purple colour.

The IRAM Newsletter is edited by Robert LUCAS at IRAM-Grenoble (e-mail address: `lucas@iram.fr`).

The IRAM Newsletter is available in electronic form:

- by using the World Wide Web: from the IRAM home page (`http://iram.fr/`), click on item "Newsletter" and follow the links...
- by means of an anonymous `ftp` account, opened at IRAM for Internet users. To access those files, please connect through `ftp` to `iram.fr` (or `193.48.252.22`) and read the `README` file. Several subdirectories are available:

Directory	Contents
`/dist/newsletter`	Recent issues of this Newsletter (one subdirectory per issue)
e.g. `/dist/newsletter/jul95`	jul95.ps is the Postscript file for the July 1995 issue.
`/dist/doc`	Documentation on IRAM telescopes and software
`/dist/proposal`	Proposal forms and Latex files to aid proposal preparation
`/dist/soft`	distribution files for reduction software

- by means of an electronic mail file server installed at IRAM (on the Alpha machine IRAM04). This file server is a file distribution service that uses electronic mail facilities to deliver files. To communicate with it you should send a message to the electronic address:
  `newsserv@iram.grenet.fr`
  For instance, to obtain a copy of the May 1992 issue, just send the one line message:
  `SENDME MAY92.PS`
  to the above electronic address. You will receive later a mail message containing the IRAM Newsletter in Postscript code. Please discard all the e-mail header information with a text editor, and send the file to a Postscript laser printer.
  More information may be obtained by sending the one line message:
  `HELP`
  Note that this file server also contains Postscript files of the proposal forms and of Plateau de Bure documentation.

We also compile a list of e-mail addresses of IRAM users (e.g., in order to send warning messages when the Newsletter is available, but also to provide fast information, if needed). If you feel your address should be on this list, please send the one line message:

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Both addresses are valid on Internet, EARN-Bitnet and EAN .... Please keep R. Lucas informed of any problem you may encounter.

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The `username` is generally the last name of the person to be contacted.