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*The
JCMT
Newsletter*

Number 18



March 2002



Sidney Arakaki (1917-2002)

March 2002 Issue Number 18

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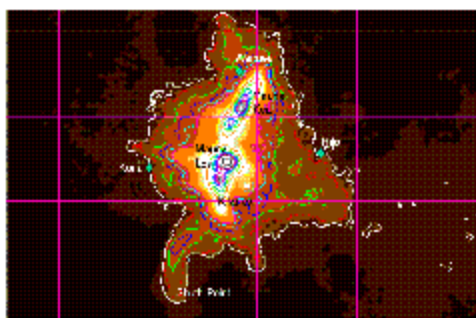
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Big Island Nebula Discovered

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From the Director's Desk



Two critical issues have occurred since the last Newsletter: agreement of the future operational plan for the JCMT and the very sad death of Sidney Arakaki. The latter matter is reported in a separate [note](#) and it is grim reminder that this is the second death in service at the JAC within the past [year](#).

As has been widely reported, PPARC, in its bid to become a member of ESO, required savings to be made in its ground-based astronomy programme of order £5M p.a. from ~2005. The JCMT was impacted by this remit and during the late summer a significant amount of management staff effort was focused in preparing a response to the requirement to come forward with a viable operating model that also delivered the target savings required. Because UKIRT was also involved, this was a JAC site-wide issue.

The report produced by the senior management with input from group leaders was extensive. Fortunately, the future scientific directions of both UKIRT and the JCMT are in the area of wide-field and survey-type observational programmes with follow-up, and for the JCMT, involvement in sub-arcsecond astronomy with the SMA. Therefore, with a reduced instrument suite and anticipated longer observing programmes, this naturally leads to the possibility of achieving savings through a different operational model. The report was presented to an international review panel (including JCMT agency representatives) in October 2001 and subsequently to the JCMTAP and Board.

Three possible savings models were derived: natural wide-field; wide-field with savings; aggressive savings-driven. All produce savings, but the amount increases with each. The first is a natural evolution from where we are now to a wide-field model but without being driven by the need to make savings. This brings a level of savings that are modest. Because the majority of the cost of the JAC is on salary related areas, this means a small reduction in the workforce. The second takes this direction further by seeking additional savings and staff losses, which will be at a level that will definitely have an impact on the "look and feel" of the JAC but where the risk to the science output should be manageable. The third model requires much higher levels of savings and staff reductions and was closest to achieving the level of savings that PPARC were seeking. In this model, the level of staff reductions was so severe that it was assessed by JAC management as far too risky to contemplate both in terms of managing the change and of producing a far too stressed operational model. A critical aspect of the model was the number of resulting single point failures through loss of key staff leading to potentially serious losses in programme delivery.

In the latter two models there is a noticeable reduction in user support and users will need to take on additional responsibility for organising their observing runs. Furthermore, major project work at the JAC becomes almost entirely serial in nature rather than parallel. This means that only one major piece of work can be undertaken on either telescope at a time. On the other hand, because of the need to retain staff due to

the arrival of new JCMT instruments (ACSYS, HARP-B, SCUBA-2) significant savings cannot readily be achieved prior to 2006.

The Review Panel, Advisory Panel and Board agreed that given the financial pressures the wide-field with savings model was the minimum acceptable operational level commensurate with scientific output. This translates into the JAC losing something around 15-18 staff, mostly expected after 2005/6. The details have yet to be agreed and depend somewhat on the future instrument reliability and programme delivery, and in any case will be for the next Director to really get into the details of managing this process. But the broad brush has now been agreed, the JCMT will focus on wide-field survey-type programmes as well as having an important role in sub-arcsecond submillimetre astronomy with our involvement with the SMA.

This brings up the question of the existing suite of heterodyne receivers. The JCMTAP were very keen that RxB3 and RxW had a significant role to play in the programme of sub-arcsecond astronomy. However, the use of these instruments as part of a single dish facility was seen to be much weaker by ~2004. It was agreed that RxA3 has a much lower priority altogether and given its age, obsolete components and lack of immediate opportunity for upgrading, its useful lifetime could be considered finite. Therefore potential future users of RxA3 are encouraged to submit programmes sooner rather than later {link}. So the future role of the JCMT is now defined. After the arrival of HARP and SCUBA-2, it will be a facility concentrating on wide-field astronomy and undertaking sub-arcsecond astronomy with RxB3 and RxW.

Turning to the development programme, the key aspect to note is that the JCMT Board has now approved committing all of the remaining funds through to the end of the Development Fund (2009) to the ongoing construction of SCUBA-2. However, such is the rate of spend on this instrument that *all these remaining funds* will be consumed around the time of the detector proof of concept critical design review in October 2002. So where will the remaining funds come from to complete SCUBA-2? The UK government (the Office of Science and Technology) has awarded £4M contingent on the full funding being identified. The bid to the Canadian Foundation for Innovation (CFI) was successful in the first selection round in December and has now been resubmitted to the final selection phase. A decision is expected in late May and because of the critical nature of the outcome for the future of SCUBA-2 and potentially the operational model and funding of the JCMT, the JCMT Board has been postponed until late June. The nature of the "savings from operations" will also be clarified in June.

As noted in a previous Newsletter, PPARC awarded funding for an outreach post and we welcome Douglas Pierce-Price who joined the JAC in December. Douglas has already stepped in and produced the JCMT poster for the Hale Pohaku Visitor Center and is now hard at work getting involved in numerous local outreach activities. At some point Douglas will also take over preparation of the Newsletters and the public web pages for both telescopes.

Finally, my two tours of duty are almost up and it is time for me to move on and return to the UK. It has been an exciting and challenging nine and a half years in Hawaii and I am very proud of what has been accomplished at the JAC. The credit of course goes to the staff, without their excellence and dedication nothing would have been possible. I should also like to thank the user community for being both supportive and understanding when things didn't happen as quickly or as efficiently as we might all have hoped for. My thanks also go to the members of the JCMT Board and Advisory Panel for their very encouraging support over the years, and to the funding agencies for their ongoing and prompt financial contributions. We all recognise that both telescopes are acknowledged world class and highly productive, the very best of their class. Both have well defined development programmes already in place and with the future operational models now agreed, the future at the JAC is rather tightly defined. I had hoped that the SCUBA-2 situation would have been decided by this point, but we should all remain optimistic that by June the last piece of the

jig-saw will have been put in place and I can then go about moving back to the UK with a degree of satisfaction and closure.



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[Ian Robson - Director JCMT](#)

Sidney Arakaki (1947-2002)



Sidney Arakaki, Head of JAC Instrumentation Support, died suddenly on 19 January 2002. Sidney was a key figure at the JAC, with more than two decades of experience - first on UKIRT, then also on the JCMT - and thus able to apply a huge amount of expertise in cryogenics, high vacuum and instrumentation. Sidney of course had many very close friends and colleagues both here at the JAC and at the UKATC in Edinburgh, and he will be greatly missed. While the professional and personal effects of his passing are perhaps not yet fully grasped, it is clear that we have lost a greatly valued colleague, a strong personality and a good friend.



Sidney with his infamous "power blender".

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RxA3 – future status.

Following on from the acceptance of the future operational model and staff reductions at the JAC staff by the JCMT Advisory Panel and Board in November, come implications for the future operational status of RxA3. The International Review of the JCMT in 1999 recognised the lower priority of RxA3 in the overall strategic plan and while it is readily accepted that high quality science results from its use, RxA3 is now starting to show its age. It has a number of components that are well and truly obsolete (including a 5.25-inch boot floppy disk drive). While the builders are perfectly willing to upgrade these, the effort to do so is not available in the near future. Furthermore, with the prioritisation of the future JCMT instrument (see [Director's Report](#)) it is clear that should RxA3 fail catastrophically sometime in the medium-term, it is probable that there will not be the effort, funding or scientific priority to ensure its resurrection. After discussions with the ITAC it was felt important that this information be widely promulgated. Therefore, this is a notification to potential users. If you have high quality RxA3 programmes in the pipeline you are urged to apply for time sooner rather than later, preferably over the coming year or so. This gives the maximum opportunity to have your programmes satisfactorily completed, either as prime programme or as backup. This call also embraces extensive survey-type programmes, which require significant observing time that can readily be undertaken in backup conditions. While RxA3 can continue to do high quality science, it is important that we maximise its capability, which will not last forever.

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[Ian Robson - Director JCMT](#)

Employment Opportunities at the JCMT

We have two openings at the moment and are seeking qualified applicants. One if for a support astronomer, and the other is for an astronomer/software support person. Please alert anyone who might be interested in working on the Big Island! Click [here](#) for further information. The closing date for both of these positions is 29 March 2002.

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[Gerald Moriarty-Schieven](#)

The Nightwatchman

Edition 3

Spring 2002

Hilo, March 1

TSS Support

Since our last newsletter, the JCMT TSS corps and the current operational model have continued largely unchanged. On the personnel front, while the four full-time TSSs continue to support the bulk of nighttime scientific operation as before, Jan Wouterloot is now partnering Robin Phillips in providing occasional augmentation to the TSS support at JCMT. Nick Jessop, who was doing likewise, departed JCMT earlier this year.

The new 16-hour nighttime operational model, which underwent an interim test period for much of last year, has effectively been ratified as the approved near-term operational model. Additionally, the TSS schedule for supporting this model has been further refined to better enable TSS coverage of the 16 hours and to allow for more flexibility and scheduling according to personal preference.

report.pl and the "Baby" OMP

As those of you who have recently observed at JCMT know, the nighttime observation reporting procedure has changed somewhat. Gone are the text-based free-form files that observers would send off at the end of an observing shift; here now is a Unix/Linux Perl-based reporting tool. This new tool is known as report.pl and is integrated with the "Baby" OMP -- the first step of the Observation Management Program.

While the observer will primarily see the nicely-formatted text and HTML versions of the report.pl program output, together, report.pl and the "Baby" OMP tools serve several purposes. First, this new reporting tool interacts directly with the template-based queue observation page, allowing real-time updates to the listings of finished and unfinished observations. Secondly, those queue observation pages, which are updated immediately and automatically, now are tied to the program databases with a new web-based front-end. This interface will better enable observers to evaluate and select which programs are most appropriate given the sidereal time and the sky opacity, thus making the nighttime observing more efficient and the observing program selection much quicker.

Additionally, the report.pl and "Baby" OMP combination has dramatically freed up members of the scientific staff from what were once tedious, manual updates of the queue observation records. This automatic database interaction saves roughly a half staff member per year (not sure which half, though) and thus allows staff to concentrate more on telescope operation and less on bookkeeping. Additionally, this reporting of observations now allows for prompt and automatic e-mailing of PIs and CoIs when data is obtained for their program and sends them information on how to automatically retrieve the pre-packaged data themselves. Lastly, this queue database allows for automatic extraction of template information, including all coordinates for the source catalog, further eliminating time-consuming bookkeeping and lessening the possibility of error.

Primarily developed by Robin Phillips, Elese Archibald, and Remo Tilanus, these recently-introduced observing tools are expected to contribute

greatly to the effective and efficient operation of JCMT. While the OMP as a whole is a larger-scale project that is envisioned to become substantially more robust, including involvement in the at-the-telescope data-acquisition process, the small-scale introduction as an automated database-oriented queue-tracking program has provided an incredibly useful tool for observers and staff alike. While the report.pl GUI will take a bit of getting used to for observers who haven't before used it, it should be a welcome interface for observers to the observation database.

You Don't Need a Weatherman...

Despite occasional hardware problems, the 186 GHz Water Vapor Monitor located in the JCMT receiver cabin has spent the much of this past semester providing a useful short-timescale opacity-measurement tool along the antenna's line-of-sight to provide additional data for comparison to opacity data obtained from the CSO, from SCUBA skydips, and from heterodyne receiver system temperatures.

Many thanks to all of you who have shown interest in our new weather page, using it not only from Hilo, HP, and Mauna Kea, but also from home institutions to eavesdrop on observations. Although incongruent with our scientific mission, the page has proved to be most popular during snowstorms! The page can be found at www.jach.hawaii.edu/~jkemp/wx.

And Now for Something Completely Different...

For those of you interested in the fascinating geology of the Big Island (or who have an intense interest in natural disaster), it might be worth taking a look at a recent article in Nature. Several vulcanologists discuss early warning signs derived from volcano slippages, specifically with respect to dramatic GPS observations of the Kilauea volcano obtained on 2000 November 8. The authors also posit that the meter of rainfall on the Big Island a week before the slippage (which perhaps many readers of this column experienced or at least viewed the resulting aftermath) might have been a contributing effect.

The original scientific article appears in the 2002 February 28 issue of Nature (volume 415, pages 1014-1018). An interesting associated commentary on the possible ramifications of the geological movement described in the original article appears in the same issue (pages 973-974). Also, an interesting, concise, and slightly lower-brow review of the findings can be found in the 2002 March 5 edition of The New York Times (Science Times section).

La Citation du Semestre

A man is a very small thing, and the night is very large and full of wonders.

Lord Dunsany, The Laughter of the Gods, 1922

Happy late spring eclipse chasing (annular solar and penumbral lunar x2)!

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Update on the JCMT Heterodyne Array Program

For several years, the heterodyne facilities on the JCMT have languished behind those for continuum. Although state-of-the-art at the time, most of the current 1 and 2-polarisation receivers and spectrometer are now almost a decade old! Consequently the JCMT will be undergoing several significant upgrades to the heterodyne system in the next 1-2 years; to include a flexible array correlator (ACSYS), low-noise B-band array (HARP-B), rapid realtime spectral display, queuing and advanced preparation of observing programmes, and data reduction using AIPS++. It is perhaps the latter two features which will directly affect how observers see the system, but it is the former that will provide the great improvement in its capabilities.

So why is all this being done? The first goal is to provide for rapid, efficient mapping in spectral lines; from the astronomers point of view, the system can then be viewed as a spectral line 3-D "camera", to complement the continuum capabilities of SCUBA and SCUBA-2. The second goal is to allow observers to efficiently prepare and queue up observations in advance and to track observation progress; this will take some of the burden off already overstretched support staff at the telescope.

Some of the performance gains of the new HARP/ACSYS system will be the following:

1. The mapping speed (to the same noise level) will be increased by factor of up to 30.
2. Widefield mapping will be possible (eg mapping 1 square degree of sky in less than an hour, with <1K rms/point).
3. Calibration accuracy, error detection and overall observing efficiency will be improved.
4. Several new observing modes will be provided (such as jiggle mapping and fast rastering).

The first phase of the heterodyne upgrade will be installation of ACSYS and a new control system, as well as the heterodyne Observing Tool by the start of semester 03a. The second phase will see the commissioning of HARP later in 2003.

ACSYS

The new array correlator and imaging system for the JCMT is nearing completion. It is being built mostly at the Dominion Radio Astrophysical Observatory (DRAO), in collaboration with the UK Astronomy Technology Centre (UKATC) and the Joint Astronomy Centre (JAC). Correlator boards have been manufactured (see pictures below), and reduction software is being completed and debugged. The final manufacture of other components such as the IF have been delayed due to shortage of effort, but it is planned that these will be available by the end of the year.

Initially, ACSYS will be integrated with the existing receivers, and so will replace the DAS. The highest resolution available will be increased by a factor of two, and maximum bandwidth will be limited mostly by

the frontend. The primary bandwidth/resolution configurations are shown in the following table.

Frontend	Usable bandwidth¹ (per mixer)	No of subbands	Best resolution (MHz) (natural weighting)
RxA3, B3, WC, WD	3.2GHz ²	4	0.5
"	1.6GHz	2	0.5
"	0.8GHz	4	0.03
HARP (all 16 mixers)	1.6GHz	2	1
"	800MHz	1	0.5
"	400MHz	2	0.06
"	200MHz	1	0.03

1. Exact usable bandwidth will depend on final ACSIS IF filters
2. Maximum bandwidth will be limited by Frontend bandwidth. Typically for existing receivers this is 2GHz

The high-level programmable nature of the new control and reduction system allows for relatively rapid development of new observing modes. It is hoped these will be refined over the first few months of use, and new ideas from observers are always welcome! However, the four *primary* observing modes available with ACSIS are shown in the following table.

Observing mode	Basic specifications	Typical uses
Raster-nod	Up to 1000 samples/row. 50 millisec/sample. Up to 1000 rows/map.	Widefield mapping

Jiggle-chop	16-point rapid jiggles using smu. Multiple ons per off.	Deep fully-sampled mapping of array field-of-view (120arcsec). Pointing.
Jiggle-frequency-switch	Jiggles with frequency switching	Efficient compact mapping
Grid/stare - nod	Takes samples at individual points	Point by point, or single point observing

In some observing modes, the raw data rate will be as much as 10Mbytes/second. To reduce this to manageable levels, ACSIS has built-in realtime data reduction, so observers will normally take home data after it has been through a full reduction process, including tasks like baseline fitting, smoothing and - when imaging - regridding onto a final map. Results will normally be available as a standard FITS cube, or for simple low-datarate modes, as a relatively raw AIPS++ measurement set format. Data can then normally be reduced using AIPS++.

The detailed user manual is being written, and is available on : http://www.roe.ac.uk/atc/projects/harp/acsis_usermanual.doc

The following figures show a fully-populated correlator crate and a single board on the bench at DRAO (images from Tom Burgess).

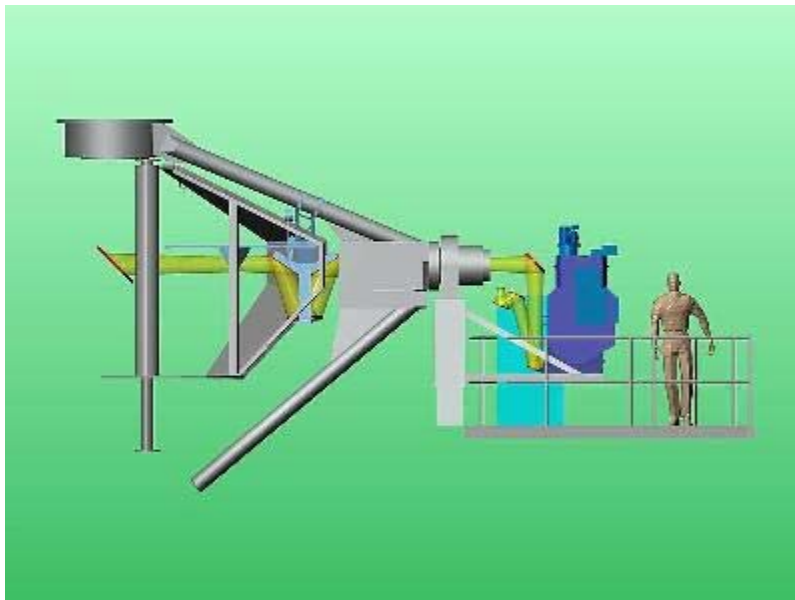


HARP-B

Is a 350GHz 4 x 4 element heterodyne focal plane array using SIS detectors presently under construction. The work is being carried out by a collaborative group led by the Mullard Radio Astronomy Observatory (MRAO), in conjunction with the UKATC, Herzberg Institute of Astrophysics (HIA) and the JAC. SIS junctions designed by MRAO for HARP-B will be fabricated by the Delft Institute of Micro-Electronics and Silicon Technology (DIMES).

Working in conjunction with ACSIS, HARP-B will provide 3-dimensional imaging capability with high sensitivity at 325 to 375GHz. This will be the first sub-mm spectral imaging system on JCMT - complementing the continuum imaging capability of SCUBA - and affording significantly improved productivity in terms of speed of mapping. The core specification for the array is that the combination of the receiver noise temperature and beam efficiency, weighted optimally across the array will be <330K SSB for the central 20GHz of the tuning range (includes the CO₃₋₂ line), i.e. - each of the 16 mixers should have a noise temperature better than the current RxB3 receiver.

In technological terms, HARP-B brings together a number of interesting and innovative features across all elements of the design. One important example is the design of the 4 x 4 imaging array module, which has a 'state of the art' SIS detector design and a novel local oscillator coupling scheme. The design also uses a cryogenically cooled Mach Zehnder interferometer for sideband filtering to minimize contributions to system temperature. The image below shows HARP-B on the JCMT. You can clearly see the HARP-B 'front-end' situated on the RHS Nasmyth platform and the HARP 'K-mirror' (a beam rotator to maintain array orientation on the sky) situated in the cabin.



So how are we doing?

Being somewhat simpler than the HARP-B camera, the K-Mirror has always been seen as almost a separate instrument and design and build progressed accordingly. In fact it has mirror surfaces that would allow any instrument operating down to about 450mm to couple efficiently to the telescope when suitably mounted on the RHS Nasmyth. The K-mirror has already gone through preliminary acceptance trials and should be shipped to JCMT and installed during the summer [2002 shutdown](#). The image below was taken at the initial acceptance test.



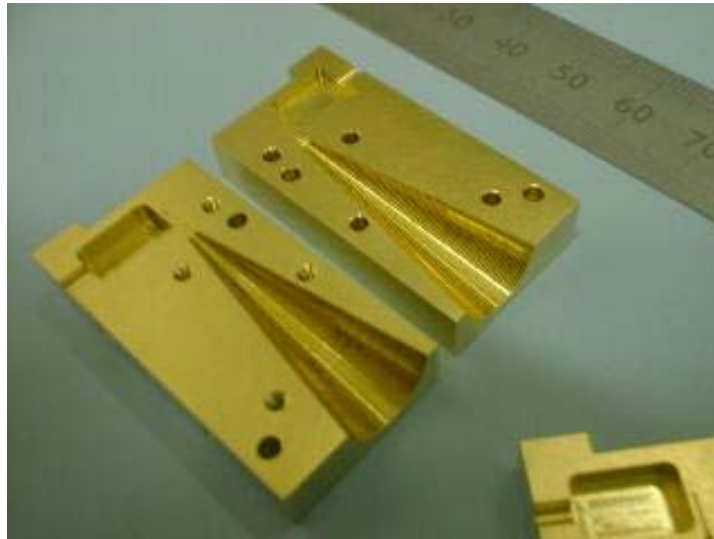
The HARP-B 'front-end' itself is also progressing well. Most of the experimental prototyping has been done and the design is essentially complete. A full, externally moderated 'Final Design Review' is planned for early summer this year. This will trigger the main build phase, which will last approximately nine months. After that comes nine more months of integration and testing in the UK before shipping to Hilo for installation & commissioning - presently planned for late 2003.

Some gallery images:

The heart of the receiver, the prototype array unit, 'looking out' of the MRAO test Dewar as it was being assembled for an LO coupling test. Note the 16 pixels!



A single prototype mixer block constructed using MRAO's 'split block' technique showing the corrugated feed-horn, waveguide, SIS junction slot and IF board pocket - about 4 weeks work in less than 30g of aluminium -machined to a tolerance of five microns.



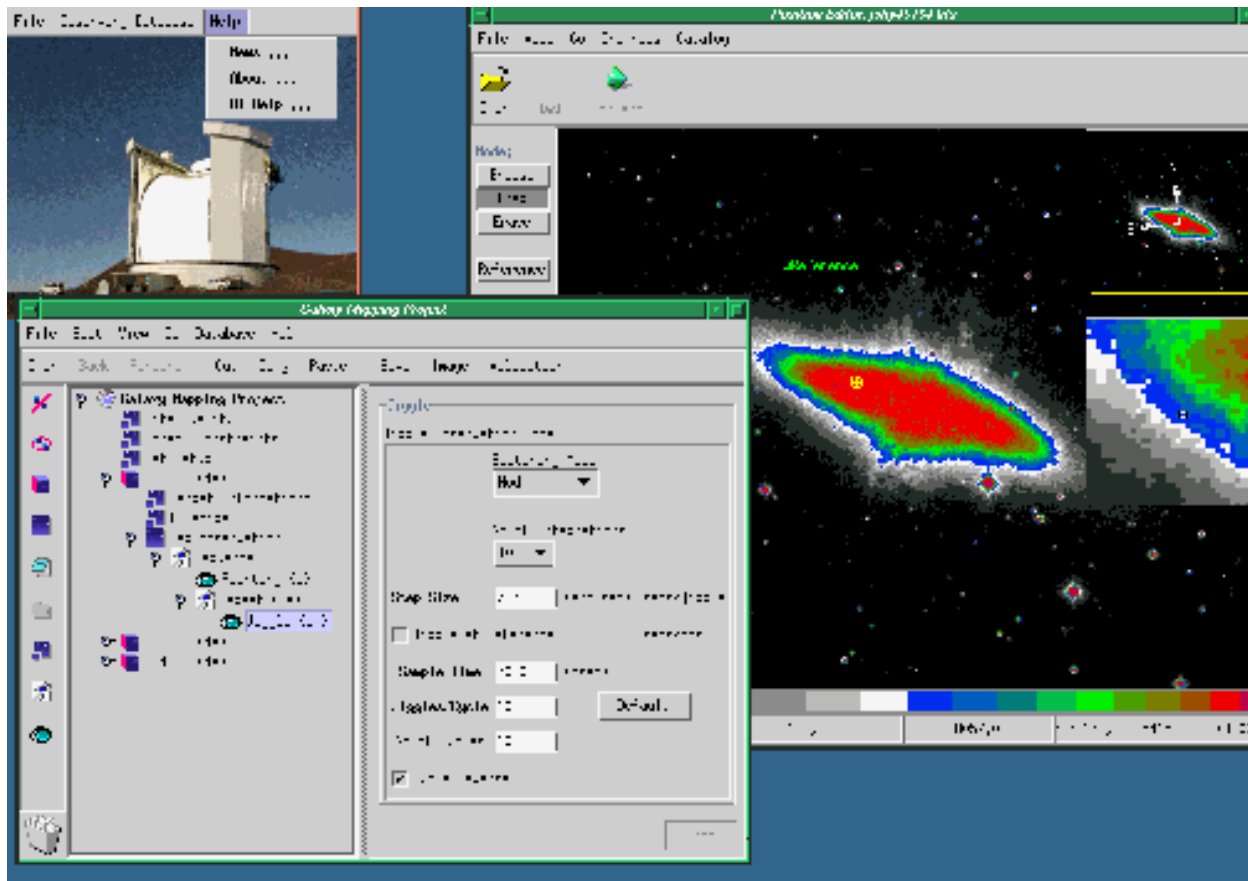
(All images from MRAO & UK-ATC)

Observing Tool

The new JCMT Observing Tool is based on the UKIRT OT, currently being developed initially for use with SCUBA at the UKATC and JAC, and then to be released with ACSIS. However most of its facilities will be common to both heterodyne and continuum observing. The idea is that once the time is allocated, the

observer can prepare their PATT programs in advance. The OT relies on the concept of "Minimum Schedulable Blocks" (luckily, shortened to MSBs), which define parts of an observation programme which can be done independently. Thus, once saved to the JCMT observation database, an MSB could be done at the most convenient and efficient time.

The example shown below is a project to make jiggle maps of three Galaxies with Harp-B. On the far left is the overall observing plan, in the form of a nested set of components describing different aspects of the programme. In the middle the components such as map area and integration times can be defined. On the right the target and map area can be overlaid and adjusted on optical catalogue images (or this could be an IRAS 60um map, for example). Although it will be possible to define a programme from scratch, for many observers a common way to prepare their run will be to read in and edit a programmes from a library of successfully tested routines.



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[Bill Dent - UKATC/ROE](#)

THUMPER - a Two HUndred Micron Photometer for the JCMT

D. Ward-Thompson, R. Evans, S. J. Leeks, R. J. Walker, P.A.R. Ade, M. J. Griffin, W. K. Gear
Cardiff University

Under the very best atmospheric conditions at Mauna Kea, a narrow atmospheric window opens at 200 microns, with a peak transmission of around 25 per cent or more during very dry weather. Figure 1 shows the predicted atmospheric transmission for different levels of precipitable water vapour.

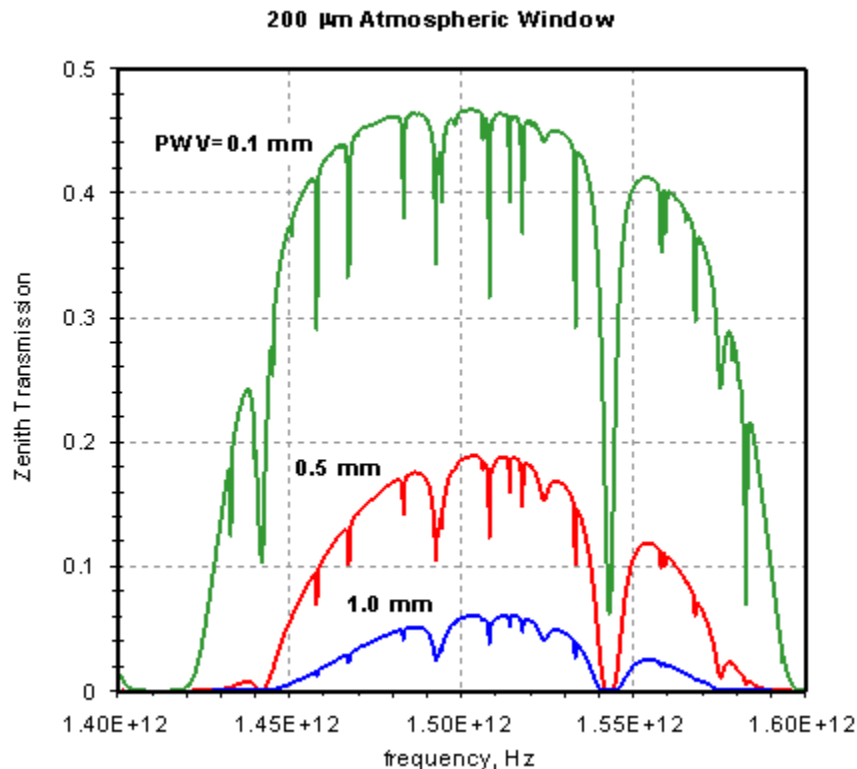


Figure 1: The predicted zenith atmospheric transmission at JCMT for various levels of precipitable water vapour between 0.1 and 1.0 mm.

THUMPER is a novel instrument, currently being built at Cardiff University, which has been designed to make use of this window and make 200 micron observations from the ground - something that has never been done before. THUMPER will have a resolution of 7 arcsec, with sensitivities comparable to that previously only attainable using airborne facilities such as KAO.

The 200 micron photometer system uses a very simple scheme to make the design, fabrication and operation as straightforward as possible. The optical layout is shown in Figure 2, and uses two mirrors with a corrector plate on the entrance window of the cryostat (as with SCUBA), to remove spherical aberration from the beam. The mirrors focus the beam into a 7-element array of Winston cones which act as feedhorns to couple the radiation from the telescope onto the detectors.

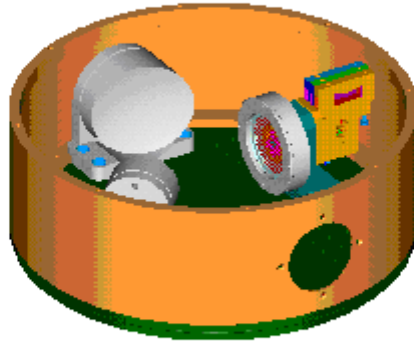


Figure 2: THUMPER optics and focal plane array of 7 detectors in a hexagonal arrangement.

The detectors are stressed Ge:Ga photoconductors operating at liquid Helium temperature (around 3.7 K at the altitude of Mauna Kea). A 200 micron filter with a passband carefully tailored to match the atmospheric window is located in front of the array of feedhorns. The detectors are read out using transimpedance amplifiers with cooled JFETs.

THUMPER will operate simultaneously with SCUBA by means of a dichroic beam-splitter in front of the SCUBA window which will allow the long wavelength (longer than 200 microns) radiation to pass unhindered into SCUBA (with 98 per cent transmission) and the short wavelength radiation to be reflected into THUMPER. Hence THUMPER will operate in 'serendipity' mode throughout all SCUBA observations, in exactly the same way as SCUBA currently takes data at 450 microns simultaneously with 850 microns. Data acquisition will take place through spare SCUBA channels, allowing the system to be used easily in conjunction with SCUBA. Software will be provided through the standard SURF interface so that to the user, THUMPER will simply appear as an additional array within SCUBA.

THUMPER will provide powerful new data for the study of many different types of astronomical sources, ranging from young stars, protostars and pre-stellar cores to evolved stars and even nearby galaxies. It will help to answer many questions relating to such sources, since its operating wavelength lies close to the peak emission of cold dust (10-30K). Used in conjunction with SCUBA at the same resolution it will provide a unique facility for JCMT.

Previously, to obtain such broad wavelength coverage, it has been necessary to combine SCUBA data with data from airborne instruments or satellites such as ISO. Figure 3 shows the pre-stellar core L1544 at 200 microns seen by ISO and at 850 microns seen by SCUBA. Note the very different scales on the axes of the images. THUMPER will provide 200 micron imaging like ISO, but at the resolution of SCUBA.

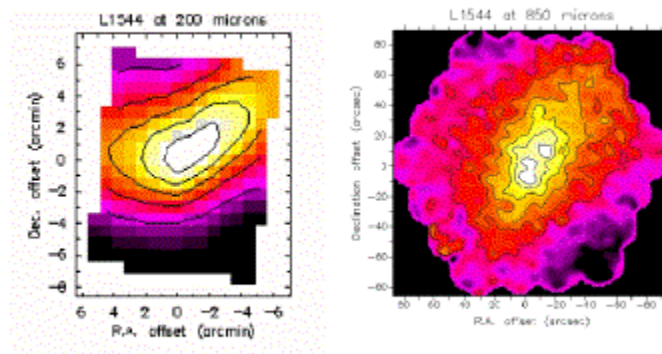


Figure 3: Images of the L1544 pre-stellar core at 200 microns taken with ISO at around 80 arcsec resolution and at 850 microns taken with SCUBA at 14 arcsec resolution. THUMPER will be able to take 200 micron images with 7 arcsec resolution.

The combination of 200 micron THUMPER data together with 350, 450 and 850 micron SCUBA data - all at very similar resolution - will help to disentangle variations of temperature, density and optical depth in cold dust sources and lead to new understanding of the astrophysics of these objects.

THUMPER is due to be commissioned on JCMT early in 2003. In the first instance it will operate in PI mode as a private instrument, due to the anticipated problems with characterising the atmosphere and calibrating data at this new wavelength for ground-based astronomy. However, the THUMPER team are happy to collaborate with members of the community on individual projects. Eventually it is hoped to offer THUMPER as a common-user instrument on JCMT.

For more information, see:

www.astro.cf.ac.uk/groups/instrumentation/projects/thumper or email: Derek.Ward-Thompson@astro.cf.ac.uk

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[Derek Ward-Thompson - Cardiff](#)

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PATT Application Deadline

Deadlines for receipt of all JCMT applications for semester 02B is:

31 March 2002

Note that the effective deadline for Canadian proposals is 4pm PST April 2 in Victoria, and for UK/International proposals is 8am HST April 2 in Hilo.

Please read the article - [Electronic Submission Update](#) before filling in your application forms for the forth-coming semester. Note that paper submissions are no longer accepted by *any* queue.

To ensure prompt processing, please ensure that your applications are sent to the correct email address in the correct format. Applications for JCMT time should be submitted to the national TAG of the Principal Investigator (PI) or, if the PI is not from one of the 3 partners, to the national TAG of the first named co-investigator on the application who is from one of the partners. If none of the investigators is employed in or by one of the partner countries, then the proposal should be submitted to the International Queue. Members of the JAC staff in Hawaii count as International unless they are the PI on an application, when it should be forwarded to the appropriate national TAG.

Country paying salary of Principal Investigator

Canada	Netherlands	UK or International
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Modification Author: Gerald Moriarty-Schieven ([gms](#))

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JCMT image here

Weather Statistics for Semester 01B

The following tables present the weather loss for semester 01B. For losses due to faults see the [Operational Stats](#). A more detailed description of how these tables are created is also available [here](#).

Month	Available	Extended	Lost to weather		Lost to weather	
			Primary	%	Backup	%
Aug	480.0	7.1	222.4	46.3	113.6	23.7
Sep	472.0	9.1	209.6	44.4	149.4	31.7
Oct	489.5	12.3	168.1	34.3	116.1	23.7
Nov	416.0	10.9	163.4	39.3	77.6	18.7
Dec	479.0	9.5	196.6	41.0	123.5	25.8
Jan	496.0	8.1	308.1	62.1	219.1	44.2
Totals	2832.5	57.0	1268.2	44.8	799.3	28.2

[Iain Coulson](#)

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Derivation of Statistical Information

This note provides some explanation on the method of production of the weather and fault statistical summary for the performance of the JCMT. There is very little manual intervention in the generation of these tables, other than to correct obvious errors, mis-labelled categories, or to complete missing entries (where they can be found from other sources).

o The data are extracted from the reports completed by the telescope operators at the end of their shift, one report for each shift (evening or morning); the shifts are normally of 8 hours duration. Because the change-over of TOs does not occur on the shift boundaries, the shift information is handed over to the following operator who will file the report at the end of shift.

o A completely separate fault reporting system is used by the TOs and other staff to record time lost to faults (including problems which have zero-time lost). This system is used by the staff to identify, trouble-shoot and solve the faults. Each fault should then have an appropriate solve report attached for future reference. This system is not used for generating statistics.

o Input from the TO reports comprises

- - the actual time scheduled (normally 8 hours);
- - any extension of this (normally due to good weather and lack of pressing daywork);
- - loss of time on primary and backup programs due to the weather.;

(NB : in flexible observing mode, the move from a high-frequency primary program to a low-frequency primary program because of a deterioration of the weather conditions does not result in any entry in the 'loss to the primary program' category.

- - loss of time to primary and backup programs due to faults, divided into 6 categories : ANTenna, CARousel, INSTRuments, COMputer, SOFTware, and OTHer. These categorizations are performed by the TO at the time of filing and persist in the analysis, although suggested changes in categories are suggested by the notes to the analysis.

(NB : faults are defined as being in respect of subsystems that have been commissioned are therefore expected to work flawlessly. If the instrument under commissioning has a fault, this is not recorded in the log.

(NB : previous correlations between faults as reported in these TO reports and via the separate fault reporting system show high levels of completeness. A similar correlation is also found between the TO reports and any completed Observer Reports for the period.

- - automated retrieval of weather conditions for the shift in question. These are not analysed further and are not further correlated with the reported conditions.

o Electronic submission of each report automatically triggers the summary analysis program

(AUTO_STATS) for the month and semester to date, and the statistics reported to the JCMT Board and in the Annual Report are essentially these results.

- o The analysis performed by AUTO_STATS may be repeated following identification and correction of spurious entries, or significant errors in categorization.

- o Occasionally reports are not filed on time, and missing reports can seldom be reconstructed.

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Gerald Moriarty-Schieven ([gms](#))

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JCMT image here

Weather Statistics for Semester 01A

The following tables present the weather loss for semester 01A. For losses due to faults see the [Operational Stats](#). A more detailed description of how these tables are created is also available [here](#).

Month	Available	Extended	Lost to weather		Lost to weather	
			Primary	%	Backup	%
Feb	448.0	14.3	149.1	33.9	127.2	28.9
Mar	488.0	32.3	118.0	24.2	49.3	10.1
Apr	480.0	19.4	202.4	42.9	61.7	13.1
May	478.5	10.5	119.3	24.9	16.3	3.4
Jun	464.0	7.0	296.8	64.0	183.2	39.5
Jul	488.0	11.2	246.4	50.5	163.3	33.5
Totals	2846.5	94.7	1132.0	39.8	601.0	21.1

[Iain Coulson](#)

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JCMT Heterodyne Instrumentation Status

The current state of the JCMT heterodyne instruments, their availability on the telescope and their sensitivities and other observational parameters can always be located on the relevant pages within the JCMT World-Wide Web site:

[Status](#) of current receivers.

[RxA3](#)

[RxB3](#)

[RxW](#)

[Heterodyne Polarimetry](#)

[DAS Spectrometer guide](#)

[DAS "non-standard" configurations](#)

[Heterodyne Integration Time Calculator](#) This facility is a web-based and stand-alone perl script for estimating the required integration time (or rms noise) for heterodyne observations.

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[Gerald Moriarty-Schieven](#)

JCMT Heterodyne Receivers

Summary and Status

Purpose

This page offers a summary of the basic characteristics of the current heterodyne (spectral line) instrumentation of the JCMT, with a forward look to the next semester. Links are provided to other pages, where more detailed information can be found regarding performance and operational details. It is very likely that the present page will be more up-to-date than the detailed pages. For a more general introduction and other information about the heterodyne instrumentation, please see the [Guide for Prospective Users](#).

Overview

The JCMT operates facility heterodyne instruments in four frequency bands, known as A, B, C and D in order of increasing frequency. The basic characteristics of these systems are given below.

Receiver system	A	B	C	D
Tuning range (GHz)	211 - 279	312 - 370	425 - 510	626 - 710
Beamwidth (HPBW, arcsec)	20	14	11	8
Beam Efficiency	0.69	0.63	0.52	0.30

Recent actual performance of the receivers can be obtained from the [Calibration Database](#).

Recent efficiency and beam shape information tends to be sparse, primarily as a result of the inaccessibility of useful planets and a lack of useful test time. Poor weather, technical faults, and receiver unavailability during September 2001 and May 2002 thwarted the most recent extended campaigns.

Note however that there are not likely to be any significant changes in basic calibration data in the past three years, especially at the longer wavelengths. SCUBA observations also indicate that the beam shape has been good, as might be expected from the continuing campaign for improved control of the antenna surface.

Click on the following for a short summary and recent updates:

- [A-band](#) (e.g. 230 GHz)
- [B-band](#) (e.g. 345 GHz)
- [C and D-band](#) (e.g. 460, 690 GHz)
- [DAS](#) (spectrometer backend to the above)

[Questions should be directed to the undersigned.](#)

Receiver A3 - 230 GHz

This receiver provides spectral coverage from about 211 to 279GHz, the lowest frequency band in which the JCMT operates for spectral line observations. The extreme frequencies can be reached with a suitable choice of sideband. A3 has a single channel with a low-noise SIS mixer having a typical noise temperature $T_{\text{rec}}(\text{DSB})$ of about 70K over most of its range. A **hump in the noise temperatures** occurs between local oscillator frequencies of 245 and 260 GHz, which appeared subsequent to leaving HIA. Although A3 does not have a single-sideband filter, one can avoid the side-effects of this feature for almost all common spectral lines with a suitable choice of sideband (note that the sideband ratio is not unity especially near this "hump"; see [results of tests](#) using HC_3N lines). Also, **close to 219.56 GHz** (C^{18}O 2-1) tuning to the upper sideband is recommended, as a local oscillator fault leads to a tuning offset for the lower sideband. For further information see the [A3 Web pages](#) and the [User's Guide](#).

Current Status

Especially during periods of relatively poor sky transmission A3 sees extensive use. It has worked reliably throughout most of the past two years, following extensive repairs to the helium cryostat and subsequent reintegration of the receiver in July 2000. Its present performance (last surveyed in February 2002; see compendium of results in [this figure](#)) continues to show some worsening of the noise "hump" since first delivered, although the frequency range affected does not appear to have expanded. Click here for [historical performance](#) (DSB receiver temperature vs time) from first light until August 2002 for the LO frequency range 226 through 236 GHz.

Anticipated for semester 04A

A3 should be in service with nominal performance, although we will be monitoring the noise "hump" for further changes.

Receiver B3 - 345 GHz

B3 has two low-noise tunerless SIS mixers which are tuned to the same frequency using a common local oscillator. The receiver tunes automatically between LO frequencies of 310 to 366 GHz; i.e. sky frequencies from 306 to 370 GHz should be accessible with one or both mixers. Observations slightly outside this range may be possible, although some manual adjustment may be required. Note that at the extremes of the frequency range the receiver noise temperature increases very substantially, and in the worse cases one or both mixers may not show true heterodyne behavior. The most recent extensive performance data, obtained in February 2002, is shown in the [attached plot](#); this can be compared with the situation in [March 2000](#). In both cases the mixer noise temperatures are color-coded - green for channel A, red for channel B.

B3 is usually used in single-sideband mode (i.e. the image sideband is suppressed), although observations are sometimes made in double-sideband mode. Both channels of B3 are capable of observing a spectral window up to 920 MHz wide simultaneously. Using a single channel allows one to observe with the spectrometer maximum of 1.8 GHz instantaneous bandwidth.

As always, we recommend obtaining "standard spectra", and observing either Mars or Uranus if possible to establish the veracity or otherwise of the temperature scale.

For additional information, refer to the [B3 Web pages](#), and/or the [User's Guide](#).

Current Status

For the most part B3 has been functioning reliably in the past year or so. Considerable effort in that time frame on the part of technical staff have done much to smooth over some remaining rough edges in B3's operation. The most recent data indicate that the characteristics of the multiplier (which was replaced in early 2002 following damage during a storm) have shifted the overall useful frequency range slightly downwards over that available until that time.

We have had some difficulty in the past year with frequent observations of **low signal strengths**; the origin of these effects has never been completely clear - in view of the large number of changes to the telescope and its infrastructure it has been difficult to make controlled experiments to isolate the cause, except to note that similar problems appear to have affected the other heterodyne receivers. Observers are urged to make careful observations of test sources. The [historical performance](#) averaged over all frequencies since first light show a marked and steady increase in the receiver temperatures with time.

Anticipated for semester 04A

B3 should be available with unchanged performance: typical DSB Trec values of between 120 and 160 K (i.e. SSB Trec's should be 250-320 K) can be expected, except at the extremes of the frequency range (outside about 315 - 365 GHz).

Receiver W - 460 and 690 GHz

This receiver consists of four mixers, two for use around 460 GHz ("C" band), and two designed for use over the 660-690 GHz region ("D" band), all mounted within a single cryostat. The two C-band channels, or the two D-band channels are normally used simultaneously to achieve improved sensitivity. The D-band mixers have tunerless (non-adjustable) backshorts, while the C-band mixers may be optimised. Receiver W is not configured to allow simultaneous operation with C and D bands, however. Receiver W is usually operated in single-sideband mode. Additional information can be found in the [User's Guide](#) and on the [Receiver W Web pages](#).

The **C-band mixers** have a typical DSB Trec value of about 150-200K over the operating range of about 430 to 510GHz. Data obtained in mid-October 2001 are [shown for the C-band region](#).

Overall during the past year receiver W has been used rather sporadically at D-band, a result of the relatively low coincidence rate of user demand and excellent sky conditions. The D-band mixers have a DSB Trec of typically 350-450K at midband. Receiver temperatures ([see D-band plot of SSB values here](#)) were surveyed in August 2001; at 660 and 691 GHz the DSB values for channels A/B were 317/376 and 441/372 K respectively. During 2001 one of the two **D-band mixers** suffered a failure and was replaced; it appears to be offer better performance than its predecessor. A failure of the LO control in the first part of 2002 removed the option of using D-band.

Basic instrumental parameters at both C and D bands remain extremely scarce, however. We had hoped to obtain a significant amount of "E&C" time in the early part of semester 01B to help rectify the situation, but poor weather conditions did not allow useful observing to be done. Observations scheduled for May 2002 were also ineffective due to problems with W and poor weather. Hence as always it would be extremely valuable for observers at C and D bands to make efficiency measurements and beam maps on planets.

Current Status

The receiver is working reasonably well, although very few observations have been carried out at D-band. July 2003 - Mixer A of C-Band is not working. It was sent to the UK for repair.

Anticipated for semester 04A

We expect current performance characteristics to be unchanged.

Spectrometer backend ("DAS")

The DAS is an autocorrelating spectrometer which provides the signal processing for all heterodyne instruments at the JCMT. Possible sampled bandwidths are 125, 250, 500, or 920MHz wide with one or two inputs (i.e. one or two mixers), or 1800 MHz with one input channel. The narrowest bands correspond to a spectral resolution of 95kHz (190kHz using two input channels). At 1.8GHz bandwidth the spectral resolution is about 1.5MHz. Some special configurations can be used to allow more than one line to be observed at the same time if the lines are suitably situated in frequency space. 1MHz corresponds to 0.87km/s at 345GHz. See the [User's Guide](#) for further information.

Current Status

The DAS is operating normally in all modes. Improved environmental control installed in last couple of years has been a welcome positive change. In recent times the DAS has suffered a number of faults associated with individual subbands, with particularly strong sensitivity to unstable input signals; this appears to be fixed after an extended visit by ("Doctor DAS") Rob Millenaar. Mahalo, Rob!

Anticipated for semester 04A

We expect the DAS to be operating normally. The new ACSIS correlator is expected to arrive within this timeframe, although it is not likely to impact regular observing during semester 04A.

For internal JAC use:

[Log form](#)

[Tests form](#)

[View previous reports](#)

JCMT home page	A3 pages	B3 pages	W C/D pages
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Please address any comments, suggestions or requests regarding this Web page to [Per Friberg](#)

Updated: 28 July 2003

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Lethbridge Fourier Transform Spectrometer

It is likely that the Lethbridge FTS will be available for use during semester 02B. Further information is available at:

<http://home.uleth.ca/phy/naylor/FTS.html>

The Lethbridge group welcomes scientific collaborations with other JCMT users. Please contact Prof. D.A. Naylor (naylor@uleth.ca) to arrange collaborative efforts.

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[Gerald Moriarty-Schieven](#)

SPIFI: The South Pole Imaging Fabry-Perot Interferometer

SPIFI is a direct detection, imaging Fabry-Perot interferometer designed for use in the submillimeter band (200 to 650 microns), especially the 350 and 450 micron windows available to the JCMT. SPIFI's detector is a 5 x 5 element monolithic silicon bolometer array cooled to 60 mK in an adiabatic demagnetization refrigerator. SPIFI uses free standing metal mesh Fabry-Perot interferometers to deliver spectroscopic images at velocity resolutions up to 30 km/s over the entire array. The velocity resolution is continuously adjustable from 300 to 30 km/s in a few minutes time at the telescope. Higher velocity resolutions (better than 15 km/s) are possible for the inner 9 pixels. The Winston cones coupling radiation to SPIFI's bolometers have 6.1" ($\sim \lambda/D$ at 450 microns) circular entrance apertures and are arranged on a 7.0' square grid, so that SPIFI images a 35" x 35" field of view at the diffraction limit of the JCMT telescope.

SPIFI may be available for use during the semester. Current best estimates of sensitivities and other parameters will be posted on the web page at the [Cornell Astronomy Department Site](#).

First light for SPIFI on the JCMT in April 1999. A report on [this event](#) was published in the [March 2000 JCMT Newsletter](#).

The Cornell group welcomes scientific collaborations with other JCMT users. Please contact [Prof. G.J. Stacey](#) at Cornell University (stacey@astrosun.tn.cornell.edu) to arrange collaborative efforts.

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[*Gerald Moriarty-Schieven*](#)

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Max-Planck-Institut 800 GHz Instrument

The MPIfR/SRON heterodyne spectrometer (MPIRE) for the 350 micron atmospheric window (E-band) has been successfully installed and commissioned at the JCMT in April 2000. The figure at the top shows the integrated system in the Cassegrain cabin. The spectrometer consists of a single-channel fixed-tuned waveguide mixer with an SIS NbTiN junction fabricated at the University of Groningen. The current tuning range of the mixer is 790-840 GHz. Among the most important lines within this band are the transitions of CO J=7-6 [807 GHz], [CI] 3P2-3P1 [809 GHz], HCO+ J=9-8 [802 GHz], and HCN J=9-8 [797 GHz].

The double-sideband (DSB) receiver temperature is in the range 500 - 800 K, the highest sensitivity is around 800 - 810 GHz. Only DSB operation is possible. The maximum available bandwidth for the DAS is currently 920 MHz. The measured single-sideband system temperatures at the JCMT are around 10,000 K or much less under good submillimetre weather conditions ($\tau_{225\text{ GHz}} < 0.05$). Preliminary analysis yields a main beam efficiency $\eta_{\text{mb}} \sim 0.15$.

The system is currently on loan from MPIfR and may be available in semester 02B for use by the JCMT community on a collaborative basis. Astronomers interested in using it should contact Ronald Stark (stark@mpifr-bonn.mpg.de) to arrange collaborative efforts. The instrument will stay at JCMT for an extended time during which a continuous improvement of its performance is planned.

Further details can be found at:

<http://www.mpifr-bonn.mpg.de/div/mm/tech/mpire.html>

Observers interested in using it should contact Dr. Ronald Stark (stark@mpifr-bonn.mpg.de) to arrange collaborative efforts.

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Modification Author: Gerald Moriarty-Schieven ([gms](#))

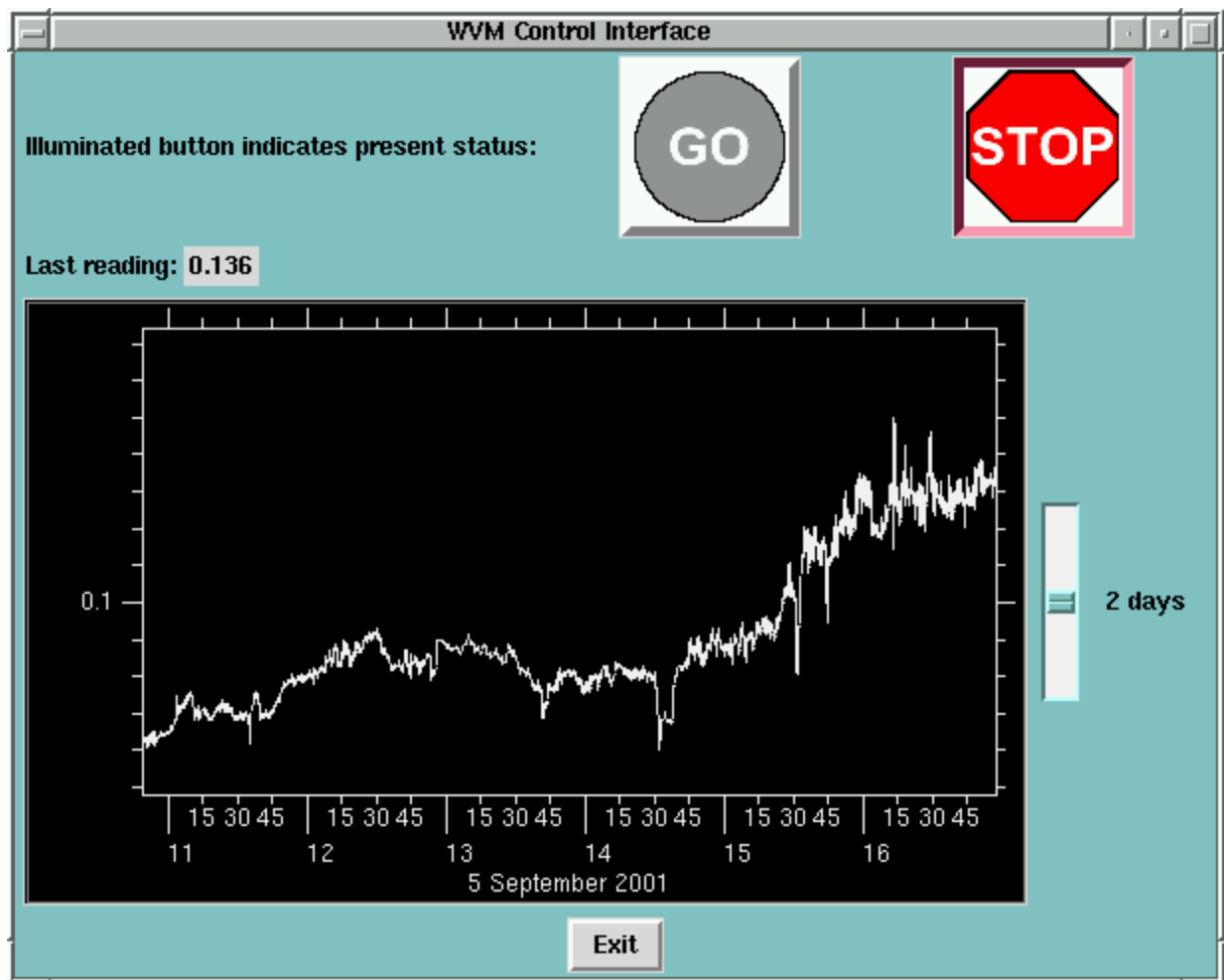
The JCMT 183GHz WVM



Since the summer of 2001 the JCMT has been regularly using a cabin mounted Water Vapour Monitor (WVM) provided to the JCMT by MRAO. Built as a thesis project by Martina Wiedner (under the supervision of Richard Hills) it works by looking at the 183GHz water vapour line using a three channel double side band receiver. The three channels enable it to provide accurate measurements in conditions ranging from very dry to very wet. By using a small pickup mirror mounted just above and to one side of the main JCMT tertiary mirror it looks almost exactly along the same line of sight that the primary instrument being used is. This feature is at its most useful in variable conditions where the CSO tau may not be giving reliable readings (if, for example, a new weather front is approaching from one horizon). With a sampling rate of 1 reading per 6 seconds it is easily able to detect individual clouds (or 'blobs' of water) passing overhead. This semester we are investigating the possibility to use it to correct the SCUBA photometry data.

The picture above shows the WVM mounted above receiver W with the pickup mirror mounted above the TMU.

The screen shot shown below is the current user interface which enables it to be started and stopped and displays recent data collected. All the data collected over the last few months has been archived.

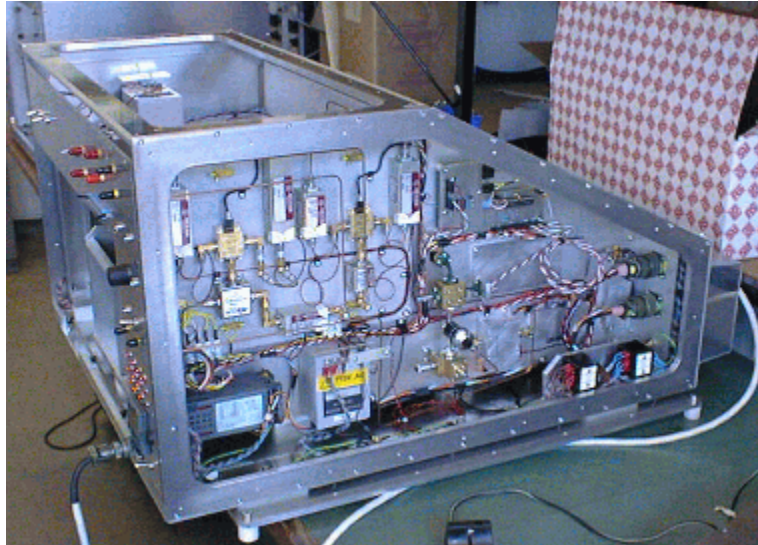


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[Robin Phillips](#)

RxH3 - The JCMT Surface

Ever since the JCMT started operation, the main method of measuring the shape of the surface has been "millimetre-wave holography". This involves making very detailed measurements of the beam of the telescope and exploiting the Fourier transform relationship between the beam pattern and the fields in the aperture to obtain a map of the surface errors. A new system for making this measurement is now in operation. These pictures shows the new receiver during its construction and as it is now, installed in the cabin (just to the left of the entrance doorway).



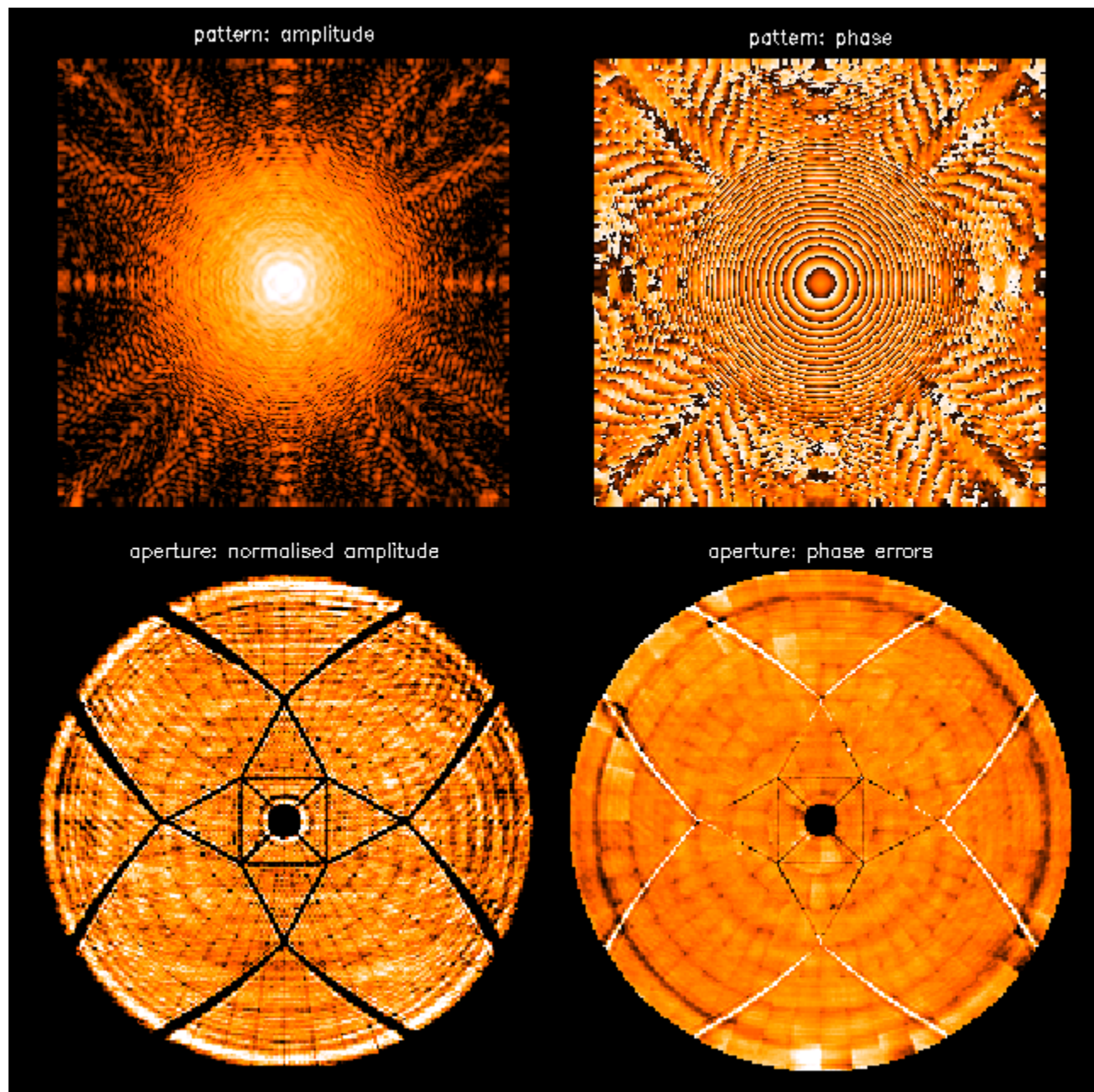
The new receiver is called RxH3. Its predecessor, RxH2, was retired on 20 February 2002 after almost 15 years of service. The old system operated at 94 GHz and consisted of a source at UKIRT and a single-channel receiver, which simply measured the amplitude of the signal. This meant that maps of the beam had to be made at two different focus settings and then a complicated analysis performed, involving least squares fitting, to recover the phase in the aperture. (Surface errors show up as

deviations in the aperture phase.) This system had several disadvantages: it took at least two hours to obtain the data; the phase-retrieval technique did not work well if the errors were very large, so several iterations of measurement and adjustment were needed if panels were a long way out of position; and the accuracy was limited because of the presence of spurious signals due to reflections, in particular from the membrane.

RxH3 is designed to overcome all these limitations. It has the following features:

- It measures both phase and amplitude. This is done by bringing a reference beam through a hole in the primary surface and into the back of the receiver, where it is correlated with the main beam arriving via the primary, secondary and tertiary.
- It operates at either 80.35 and 160.7 GHz. Both these frequencies are emitted simultaneously (on orthogonal polarizations) by the new source unit, which is located inside the UKIRT dome. There are two sets of mixers in the receiver to collect these signals.
- The frequency can be stepped rapidly over a few tens of MHz. This makes it possible to remove the effects of spurious signals.
- The backend obtains very high dynamic range by having both high- and low-gain ranges.
- The real-time VME-based data-acquisition system can take samples at a rate of up to 1 kHz and these are time-stamped and then associated with accurate readings of the telescope position. (The maps are taken "on-the-fly" with the telescope performing a raster scan at speeds of up to 400 arcseconds per second.)

The new instrument was designed and built as a collaborative effort involving MRAO, JAC and RAL. Most of the design and development was carried out at MRAO, who also provided the analysis software. Much of the hardware was built at RAL, while the JAC designed and built the data-acquisition system and integrated the instrument into the JCMT environment. A great deal of time and effort has been taken up in commissioning and de-bugging the system, but this is now essentially complete. There is still a good deal to be done in the way of understanding all the properties of the new instrument, finding the best way of using it and making automatic such steps as the generation of a set of moves which can be sent to the surface adjusters. RxH3 itself and its software is, nevertheless, fully operational and producing good data, as can be seen from the next picture.



This shows a high-resolution data set obtained at 160 GHz. The two upper images are the measured phase and amplitude of the beam pattern (after re-gridding and the application of various calibration steps) and the lower ones are the phase and amplitude in the aperture. These were obtained by taking a Fourier transform and applying corrections for near-field effects and the illumination pattern of the receiver.

Prominent features of these images are: the shadows of the legs that support the secondary mirror; and the rings towards the outside of the aperture, which are due to diffraction at the edge of the secondary mirror. These are, however, of mostly academic interest and are normally removed in further processing to reveal the errors in the surface. The resolution of these images is about 80 mm so we can easily see individual panels which are out of position (e.g. at the bottom of the dish) and in fact it is also clear that there are significant errors within some of the panels - essentially "curled edges".

With the new holography system it should be possible to make measurements with an accuracy of

about 5 microns and to do so rapidly enough to understand the thermal deformations of the telescope in the course of a night. At the time of writing the surface error is higher than we would like and this is mostly due to adjusters that are not responding when commanded to move. This is presumably due to problems with either the adjusters themselves or the connections, limit switches, etc. It is hoped that it will be possible to repair these over the coming months. When the adjuster system is working well enough to allow frequent updates to the surface, it should be possible to remove most of the thermal deflections. At that stage users should start to enjoy the best beam patterns and highest efficiencies that the telescope has ever produced.

It should be remembered that at 450 microns the aperture efficient of the JCMT is still quite low and there is a significant error lobe (a "skirt" around the main beam) which can cause misleading results. We are on a steep part of the curve where even quite small reductions in the surface error will bring considerable benefits. It is expected that, whereas in the past the errors in measurements were a substantial contribution to the overall surface error, this will no longer be so with the new measurement system.

Current information about the JCMT surface can be found on the [Surface homepage](#).

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[Jan Wouterloot](#)

Tau, Seeing, and Sensitivities

When you are writing your proposals (and observing templates, should you be awarded telescope time or fallback time), remember that there are web-based tools to assist you with calculating RMS noise of your observations.

The SCUBA integration-time calculator is available [here](#).

The heterodyne integration-time calculator is available [here](#).

High quality projects that can be done in poor weather (band 4/5) are always in demand. The opacity in the A-band window is typically a factor of 4 less than at 850 microns, so one could argue that working with receiver A in $\tau = 0.3$ is similar to working with SCUBA 850 in grade 2 conditions - certainly excellent results can be achieved. The following table should give you some idea of whether your project could be done with receiver A (or B) in grade 4 or 5 weather, and just how bad the weather can be before it's pointless to continue.

If τ is 0.15 you get a certain rms in one hour.

If τ is 0.20 you'll get the same rms in 1.4 hours

If τ is 0.25 you'll get the same rms in 2.0 hours

If τ is 0.30 you'll get the same rms in 2.6 hours

If τ is 0.35 you'll get the same rms in 3.2 hours

If τ is 0.40 you'll get the same rms in 4.0 hours.

Note that *tau* and *seeing* data can now be downloaded from the archive for any date/time from 1997 onwards. Click [here](#) for more information.

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[Gerald Moriarty-Schieven](#)

SCUBA Observations of Gamma-Ray Burst Host Galaxies

Edo Berger and Shrinivas Kulkarni
California Institute of Technology

Hervé Aussel and Len Cowie
IfA, Hawaii

Dale Frail
NRAO

Introduction

One of the major thrusts in modern cosmology is to trace the formation and evolution of galaxies from high redshift to the present. This effort involves mapping the evolution of star formation and metal abundances, as well as galaxy morphology, in order to gain both a direct picture of the galaxy evolution process, and to constrain models and simulations.

The star formation history is most easily studied in the optical/UV mainly because of the sensitivity of current telescopes (e.g. Keck and HST) in these bands. However, even in our own Galaxy, which has a modest star formation rate (SFR), stars mainly form in dusty regions. As a result, it is not clear whether optical/UV observations faithfully measure the SFR since dust extinguishes radiation in these bands, and re-emits it into the far-IR (FIR) and sub-mm bands.

The first indication that star formation in dust-enshrouded regions may be dominant on a cosmic scale came from observations of the sub-mm extragalactic background light (SEBL) with the COBE satellite (Puget et al. 1996). However, since the SEBL represents an integrated history of star formation, these observations do not provide information on the redshift evolution of obscured star formation. This crucial information only became accessible with the advent of SCUBA on JCMT, which allowed a large fraction of the SEBL to be resolved into individual sources. Targeted and blank-field SCUBA surveys have uncovered a population of very luminous, high redshift galaxies, which host a significant fraction of the cosmic star formation (e.g. Smail et al. 1997; Barger et al. 1998; Blain et al. 2002).

Still, despite the pioneering work of SCUBA (and other sub-mm instruments), an exact determination of the evolution of obscured star formation has been confounded by the unknown redshift distribution of the sub-mm population. This is due to the lack of precise localizations of sub-mm sources (typical beam-sizes are ~ 10 arcsec), and the lack of sufficiently bright optical counterparts in the majority of cases. As a result, there is still an on-going debate regarding the fraction and redshift evolution of obscured star formation, and whether it is really missing from optical/UV surveys (Madau et al. 1996; Blain et al. 1999; Adelberger & Steidel 2000). SIRTf and ALMA will contribute significantly (and perhaps decisively) to these questions.

The Host Galaxies of Gamma-Ray Bursts

An alternative, and perhaps more timely, way of breaking the deadlock is to study a different population of high redshift galaxies, which is potentially devoid of some of the biases inherent in the current samples. The host galaxies of gamma-ray bursts (GRBs) provide such a sample for the following reasons:

1. **Redshifts and Luminosities:** Thanks to the bright optical afterglows of GRBs, the redshifts of the host galaxies can be determined regardless of their brightness, via absorption spectroscopy; as a result, even hosts with ~ 29 mag have known redshifts.
2. **Immunity to Dust:** The immense dust-penetrating power of the gamma-ray emission from GRBs results in a sample that is independent of the dust properties of the individual galaxies. Thus, the sample is potentially representative of the general population of star-forming galaxies.
3. **Very High Redshift:** GRBs are so bright that they are detectable to redshifts > 20 (should they exist; Lamb & Reichart 2000). At present, the redshift record-holder is GRB000131 at $z=4.5$ (Andersen et al. 2000).

The first point in particular offers a significant advantage over current sub-mm surveys since accurate redshifts and positions allow us to trace the evolution of star formation in detail and perform multi-wavelength studies of these galaxies. In addition, the immunity of GRBs to dust results in a sample of galaxies which possibly bridges the extremely dusty SCUBA-selected galaxies, and the relatively dust-free optical/UV-selected galaxies.

At present, the main limitation of the GRB sample is that it is small, numbering about 30 sources (the sample is currently growing at a rate of one per month, but is expected to increase to one per few days after the 2003 launch of SWIFT). However, the severity of this problem diminishes when one realizes that the number of securely-identified sub-mm galaxies is several times smaller (e.g. Frayer et al. 1998).

We note in passing that the bright optical afterglows of GRBs are also powerful tools for studying the evolution of metal abundance in the disks of high-redshift galaxies, as well as the intergalactic medium. In particular, unlike quasars, which shine continuously and ionize their surroundings, GRB afterglows illuminate the line-of-sight without modifying the material on galactic scales, thus providing unique information on the chemical composition at all redshifts.

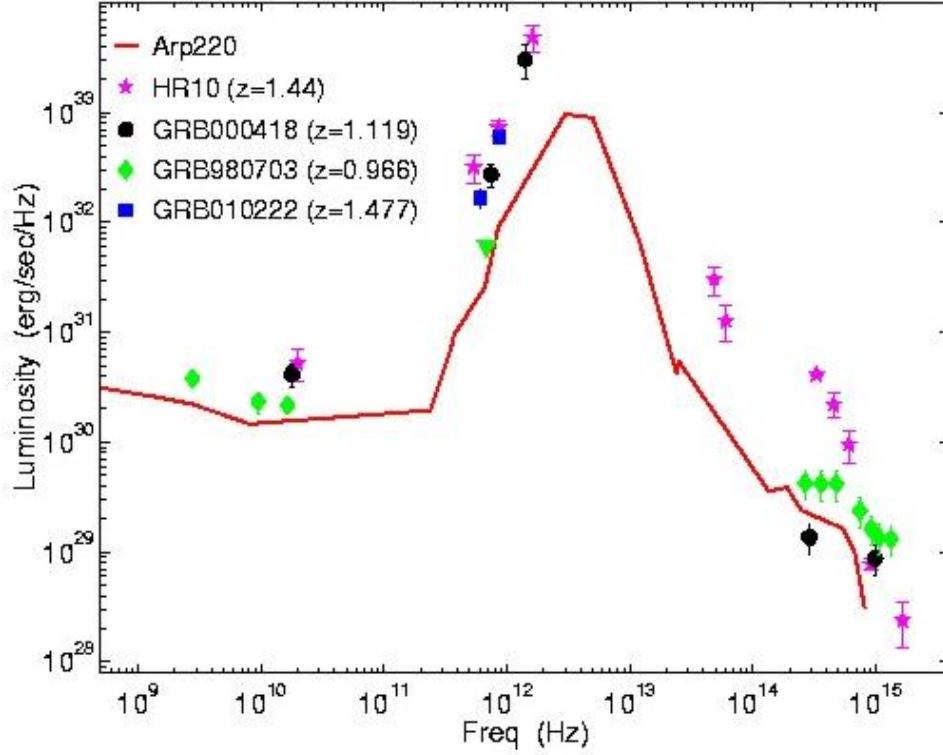
A SCUBA Survey of GRB Host Galaxies: Results to Date

Initial work with SCUBA concentrated on target-of-opportunity observations of the afterglows themselves, often in less than ideal observing conditions. These observations, summarized by Smith et al. (1999 & 2001), provided only loose constraints (typical $1\sigma=1-3$ mJy) on the combined emission from the afterglow and host. Recently, this work has been superseded by the detections of the host galaxies of GRB980703 (VLA) and GRB010222 (SCUBA) by us and colleagues. In the case of GRB980703 we detected a non-fading radio source at the position of the burst (Berger et al. 2001a), while SCUBA observations of GRB010222 revealed a constant sub-mm source (Frail et al. 2002).

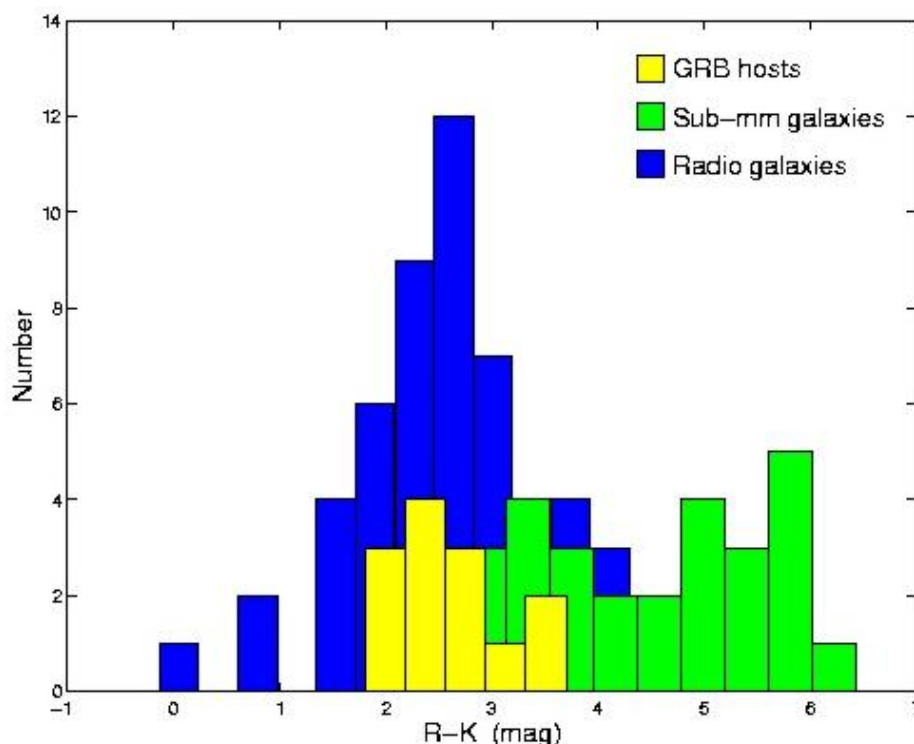
Motivated by these detections, and the unique potential of GRB host studies, we have begun an intensive program of host galaxy observations at JCMT, with a synergistic program at the Very Large Array. Over the past several months we observed thirteen host galaxies in the standard photometry mode and we are happy to report another detection, the host galaxy of GRB000418 (see also Berger et al. 2001b). Three additional hosts have fluxes ~ 2 mJy. Including the previous detections, this means that approximately 20-40% of GRB hosts have bolometric luminosities and star formation rates, which classify them as Ultra Luminous Infra-Red Galaxies (ULIRGs). This fraction matches the prediction of Ramirez-Ruiz et al. (2002), which relies on the assumption that GRBs trace massive stars.

In Figure 1 we plot the spectral energy distributions of the three securely-detected GRB hosts, in comparison to the

local ULIRG Arp220, and the $z=1.44$ extremely red object HR10. The GRB hosts are more luminous than Arp220, and have a comparable luminosity to HR10. Optical imaging and spectroscopy of these host galaxies do not reveal such vigorous star formation activity, implying significant dust obscuration.



However, despite the resemblance to Arp220 and HR10 in the radio/sub-mm regime, the optical properties of the GRB hosts reveal that they represent a somewhat different population than the SCUBA-selected galaxies. In Figure 2 we plot a histogram of R-K color for SCUBA-selected galaxies (Chapman et al. in prep.), radio-selected galaxies (Haarsma et al. 2000), and several GRB hosts. All of the sub-mm selected galaxies have $R-K > 3$, and 2/3 have $R-K > 4$. This is expected since the high dust content in these galaxies tends to redden the optical colors. On the other hand, close to 80% of the GRB hosts have $R-K < 3$. Thus, the host galaxies that have been detected with SCUBA so far represent a population that would have been missed in the traditional SCUBA surveys, and at the same time would not be classified as ULIRGs based on optical data.



At present, it is difficult to interpret these results, but it is possible that GRB hosts represent younger starbursts, while the typical SCUBA-selected galaxies host more evolved population of stars. Regardless of the exact explanation, it appears that current sub-mm surveys miss a certain fraction of the cosmic star formation, which can be possibly recovered by observations of GRB hosts.

Future Work

The field of sub-mm and radio observations of GRB host galaxies, as well as other high-redshift samples, is still in its infancy. Over the past several years great strides have been made in our understanding of the cosmic star formation history, especially thanks to SCUBA, and the results of our initial SCUBA observations of GRB hosts indicate that this new sample brings a fresh and unique perspective into the field. In the near future, our continued program will rely on the growing sample of GRB host galaxies, and current sub-mm and radio facilities. On a longer timescale, we anticipate a revolution in the capabilities of sub-mm and radio instrumentation, and a substantial growth in the number of GRB host galaxies with accurate localizations and redshifts. The advent of instruments and observatories such as SCUBA-2, the Expanded VLA, the Square Kilometer Array, SIRTF, and ALMA, will allow us to study the properties of these hosts with ever-increasing sensitivity and resolution.

One of the issues that may be addressed by these improved observations is whether the subset of optically-dark GRBs lack an optical afterglow because they are located within the dense environs of giant molecular clouds. If so, the fraction of GRBs with no optical afterglow will provide an independent estimate of the fraction of obscured star formation at cosmic scales.

Thus, as more GRB host galaxies are detected and studied in detail in the sub-mm and radio, we will be able to address a large number of issues pertaining not only to the nature of GRBs and their hosts, but also to the characteristics of galaxies at high redshifts.

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Polarization Data in Perseus Reveal a Core without a Polarization Hole

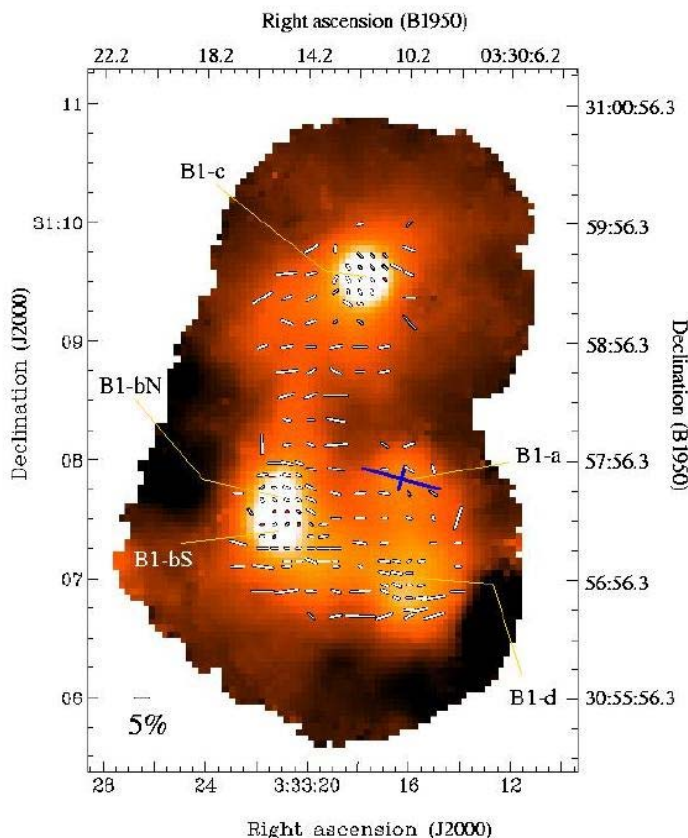
[Brenda C. Matthews](#)

UC Berkeley

& [Christine D. Wilson](#)

McMaster U

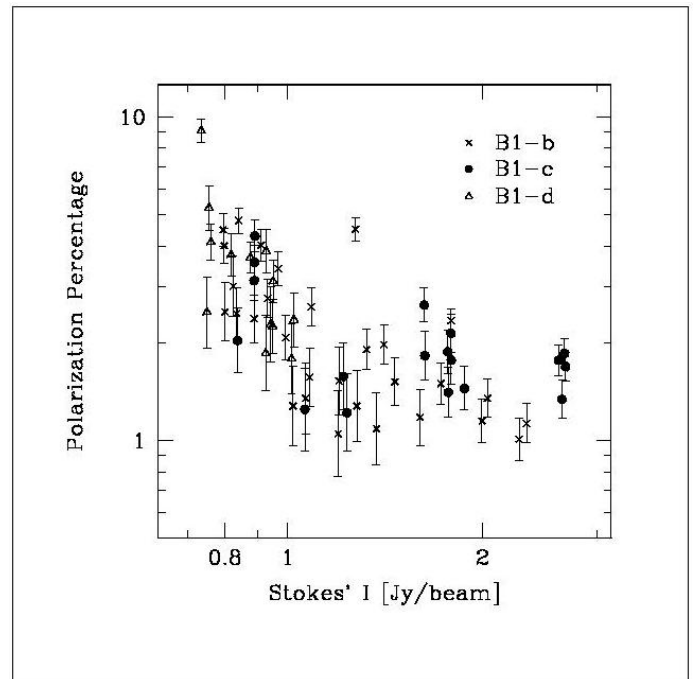
Observations toward the centre of the dark cloud Barnard 1 in Perseus using the SCUBA polarimeter at 850 microns reveal several dusty cores, labelled B1-a through B1-d on Figure 1 (Matthews & Wilson 2001). The greyscale traces the column density in dust emission while the vectors show the net polarization percentage and position angle summed through the optically thin cloud. (The blue cross marks the position of IRAS 03301+3057.) The polarization vectors are binned to 6" spacing within the cores and 12" in the lower column density dust. Interestingly, the vectors in the cores are strongly aligned but each core exhibits a different position angle. These angles are in turn different from the position angle of 90° E of N measured toward the faint dust. Rotation of these vectors to infer a magnetic field direction would produce an extremely disjointed field with sharp changes in projected field direction at the core boundaries.



In Figure 2, we have plotted the behavior of the polarization percentage versus the dust intensity for several of the cores. The B1-d core is quite faint and exhibits the typical decline in polarization percentage with intensity to its peak. However, the B1-b and B1-c cores show a deviation from this behavior; beyond an intensity of 1 Jy/beam, the polarization percentage ceases to decline. (We have truncated our data sample at $p < 1\%$, resulting in the removal of 5 vectors [shown in red on Figure 1] from B1-b and 1 vector from B1-c. This could be creating an artificial threshold for B1-b, but cannot account for the behavior for B1-c.) The threshold does not appear to be due to optical depth effects, since even at the B1-c peak, we estimate $\tau < 1$. Additionally, no polarized emission would be expected from an optically thick source, since

would be equal.

Based on the B1-c data, the polarized intensity ($p \times I$) in fact increases to the peak of that core. This means the high density dust is likely contributing to the polarized emission. In other observations of star-forming (e.g. Greaves et al., 1999; Greaves et al. 1995) or starless cores (Ward-Thompson et al., 2000), the constant decline in polarization with intensity has been interpreted as evidence that only dust grains up to a nominal extinction contribute to the polarization we measure. Since all grains contribute to the total emission, the polarization percentage (polarized/total intensity) drops toward core peaks.



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Searching for massive protostars

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[Lee Mundy](#)
(Maryland)

Introduction

Massive protostars are hard to find because the Kelvin-Helmholtz timescale is shorter than the free-fall timescale for massive stars which means that massive stars begin burning hydrogen before they have finished collapsing. Also massive star-forming regions are typically more distant than their commonly-observed low-mass counterparts and massive stars form in clusters making confusion a severe problem.

Ultracompact HII regions and hot molecular cores are well-known phases in the early evolution of massive stars, but they are phases where a central compact object has already formed and is pouring energy into its surroundings. What about stages prior to this point? Can we detect and identify massive pre-protostellar cores?

A JCMT-BIMA-JCMT survey

An initial SCUBA survey by Thompson et al. (2002) of ultracompact HII regions (UCHIIs) from the Wood & Churchwell (1989) and Kurtz et al. (1994) radio surveys revealed a number of interesting sources with extended dust emission and/or multiple dust peaks within the SCUBA field of view. We have since followed up these observations with a survey of 10 UCHIIs using the 10-element BIMA interferometer at 3 mm (roughly 10-arcsec resolution). We employed a variety of tracers to simultaneously probe the quiescent and highly-excited gas.

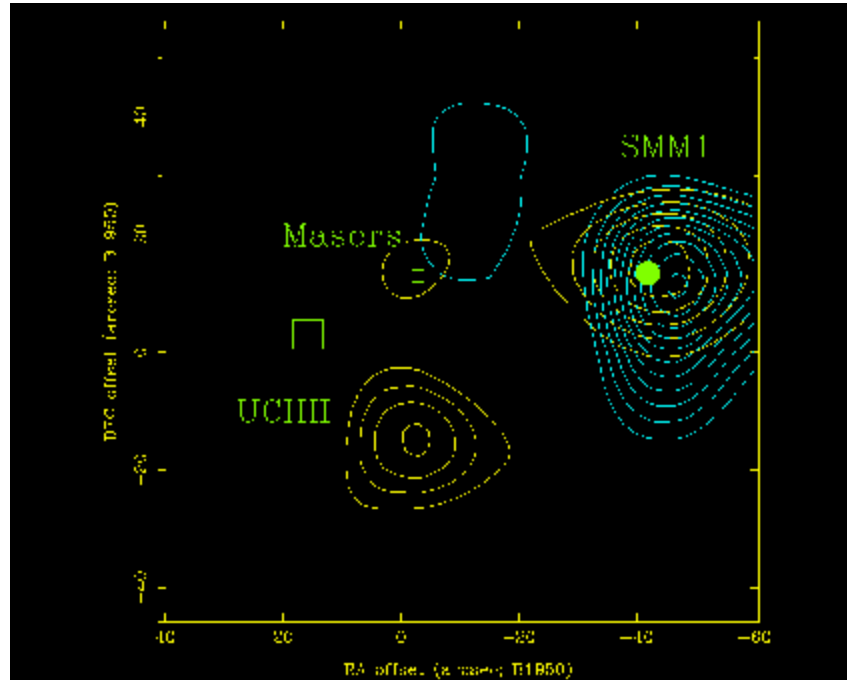
The BIMA survey was spectacularly successful: observations of N₂H⁺ 1-0 in all 10 sources resulted in the detection of approximately 50 cores, the majority of which were not known of previously. More importantly, most of these cores have no known infrared (IRAS or MSX) or radio sources within them, nor other signs of massive star formation such as water and methanol masers. Even more intriguing is the fact that a number of these cores are weak in C¹⁸O 1-0 emission, suggesting that CO molecules may be freezing out, and therefore that the core may be collapsing (Bergin & Langer 1997; Rawlings et al. 1992).

Such discoveries had us back at the JCMT for further followup observations to confirm our depletion interpretation (although we are unable to say as yet), search for outflows associated with some of the warmer cores we found in our BIMA results and look for kinematic signatures of collapse.

New outflows

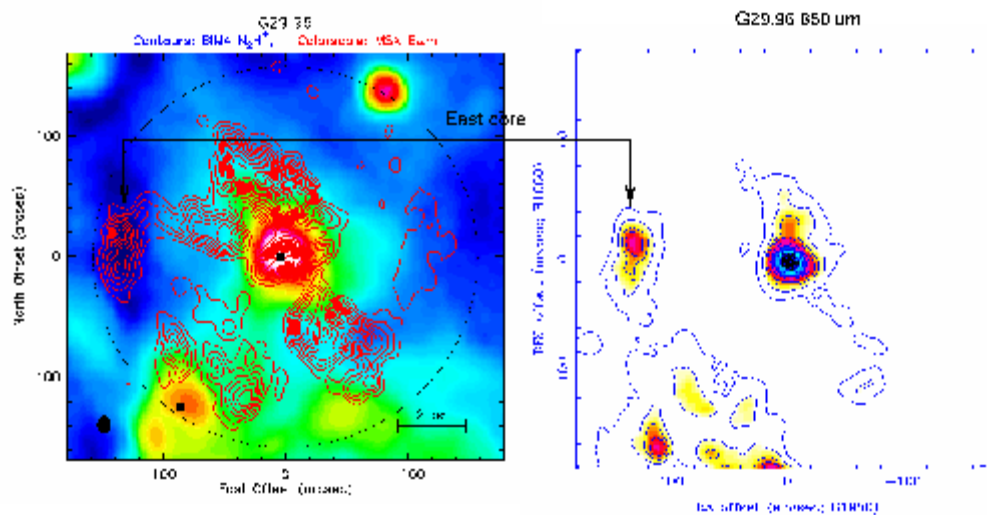
Thus far we only have CO data on G35.20-1.74 but it was obviously a good place to start as we have already discovered a new outflow and evidence for CO outflow associated with a known maser source. Figure 1

shows high-velocity red (yellow contours) and blue shifted (blue contours) CO 3-2 emission in G35.20-1.74. The large open square marks the position of the UCHII region, the small open square the position of the methanol and water masers and the filled circle one of the submillimetre peaks from our SCUBA maps. The compact outflow at the west edge of the image is centred on a molecular peak bright in N2H+, C18O and CH3CN indicating the likely presence of a hot-core-like source. The maser positions also appear to be at the centre of a second CO outflow.



The promise of wide-field imaging

Some of the fields we observed (such as G29.96-0.02) were so rich in new cores that we decided to extend the mapping to include a larger area to search for further sources. Figure 2 shows a comparison of the BIMA and SCUBA images for G29.96-0.02. The agreement between the 850-micron dust emission and the 1-0 N2H+ emission is amazingly good, even out to the east where a new ridge of dust emission was revealed by our SCUBA scan-map (marked 'East core' in Figure 2). No radio or infrared sources are observed towards this core; neither are any masers known. We estimate a mass of $\sim 8500 M_{\text{sun}}$ for this core.



The BIMA N₂H⁺ data are superimposed on the MSX 8-micron image of the same region. It is interesting to note that the MSX data show no signs of point sources within any of the newly-discovered molecular/dust cores. What is even more interesting is that the eastern dust ridge shows up towards a region which is essentially dark at 8 microns. This is a very good indicator that the high dust column density we measure at this position with SCUBA is due to *cold* dust and that here may be one site where the next generation of massive stars will form.

Summary and future work

Our BIMA results have shown that N₂H⁺ is an excellent tracer of the dense gas in regions of massive star formation. It is such a pity that RxA3 cannot tune to the 3-2 line and that it is difficult to get the 4-3 line with RxB3 as they would undoubtedly be excellent transitions for constraining the properties of the gas traced by the 1-0 line. We are working on determining whether or not we are seeing signs of depletion and are continuing the JCMT study to look for outflows and collapse signatures.

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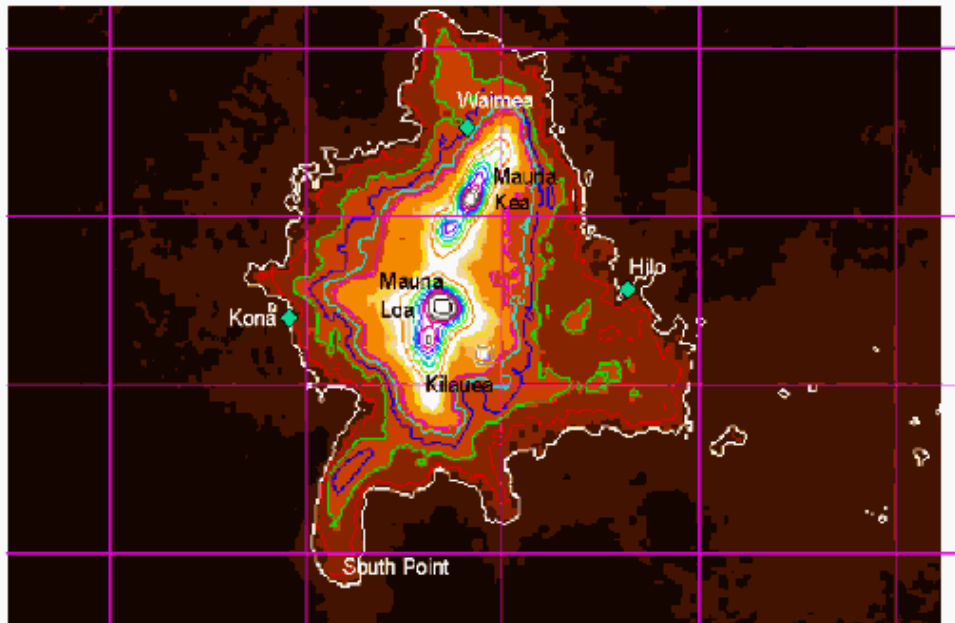
[Andy Gibb - UMaryland](#)

The *Big Island* Nebula

[Lorne Avery](#)

(National Research Council of Canada - Herzberg Institute of Astrophysics)
& The Canadian Consortium for Star Formation Studies

A team of Canadian astronomers working at the world-famous James Clerk Maxwell Telescope in Hawaii have announced the discovery of a remarkable new star-forming nebula. This image of the region, provided by Lorne Avery of the Herzberg Institute of Astrophysics, shows the outline of strong 850 μ m emission from dust warmed by numerous young stars that have formed recently within the nebula. It is customary in astronomy for the discoverers of new objects to suggest an appropriate name. The discovery team will recommend that the IAU adopt the name "Big Island Nebula" for this remarkable region. Situated at a distance of 500 pc, in the vicinity of the famous Horsehead Nebula in Orion, this object will no doubt become well known to astronomers and the public alike because of its remarkable resemblance to the Big Island of Hawaii which, by coincidence, is the home of the James Clerk Maxwell Telescope. Rumours of a Nobel Prize in recognition of this outstanding advance were dubbed "premature conjecture" by the award committee, although a spokesperson for the committee described the discovery as "remarkable".



Big Island Nebula Discovered

Actually, apart from the geographic labels, this is an exact, unretouched 850 μ m SCUBA image of NGC2024 obtained by the Canadian Star Formation Consortium. This is precisely how the gaia image came up on the computer screen. I was struck by the obvious resemblance to the Big Island. The field shown is about 7 x 10 arc minutes.

Scientific highlights with SPIFI on the JCMT

Gordon Stacey (*Cornell*)

The South Pole Imaging Fabry-Perot Interferometer (SPIFI) is a direct detection imaging spectrometer designed for use on the 15 m JCMT and on the 1.7m AST/RO at the South Pole in the 350, and 450 mm submillimeter windows. SPIFI had a very successful first light in April 1999 (see 1999 JCMT newsletter), but was not blessed with submillimeter weather again until our April 2001 run. During this highly successful run, we focused on mapping the Galactic Center, nearby galaxies, and W 49 in the [CI] (370 mm) and CO(J=7@6, 372 mm) rotational lines. Here we focus on the results from the Galactic Center, M82, and NGC 6946.

In its primary configuration, SPIFI can access any line in the 350 mm telluric window, but the primary lines are the $^3P_2 \rightarrow ^3P_1$ [CI] 370 mm fine structure line and the CO(7@6) rotational transition. These two lines are only 1000 km s^{-1} apart, so that both can be included in a single spectral scan using SPIFI. Therefore, SPIFI maps in these two lines will have excellent relative flux calibration and registration. The mid-J CO rotational lines probe the warm dense gas associated with photodissociation regions (PDRs) and molecular shocks, and together with lower J lines trace the strength of the far-UV radiation field, and the gas density. Much of the molecular gas in Galactic star formation regions, the Galactic Center, and external galaxies, is both warm and dense, so that mid-J CO line studies are critical to understanding the interplay between star formation and the natal molecular clouds on galactic scales.

Neutral carbon is nearly as abundant as CO in the ISM, and the [CI] lines are easily excited, so these lines are important coolants of PDRs, and even cloud interiors. In dense clouds, the line ratio is temperature sensitive, while for more diffuse regions, there is a density dependence as well. Both [CI] lines are normally optically thin, so that they trace mass, so that their study traces mass, cloud structure and dynamics.

During our April 1999 run, we mapped the entire CNR in the CO(7@6) line at a velocity resolution of 70 km s^{-1} (Figure 1, left). The CO emission is morphologically similar to the far-IR continuum emission (tracing PDRs) from the circumnuclear ring (CNR), and that the CO emission is largely, but not entirely interior to the CNR as traced by its HCN emission. Our LVG excitation model of the line emission indicates the material is both warm ($T \sim 240 \text{ K}$), and dense ($n \sim 7 \times 10^4 \text{ cm}^{-3}$), with a total mass ~ 2000 to $3000 M_\odot$. The luminosity source is magneto-hydrodynamic shocks from modest velocity ($v \sim 10$ to 20 km s^{-1}) gas encountering modest (~ 0.3 - 0.5 mG) magnetic fields. The observed CO luminosity suggests that about 10 to 50% of the dynamical energy of the CNR is dissipated on an orbital timescale.

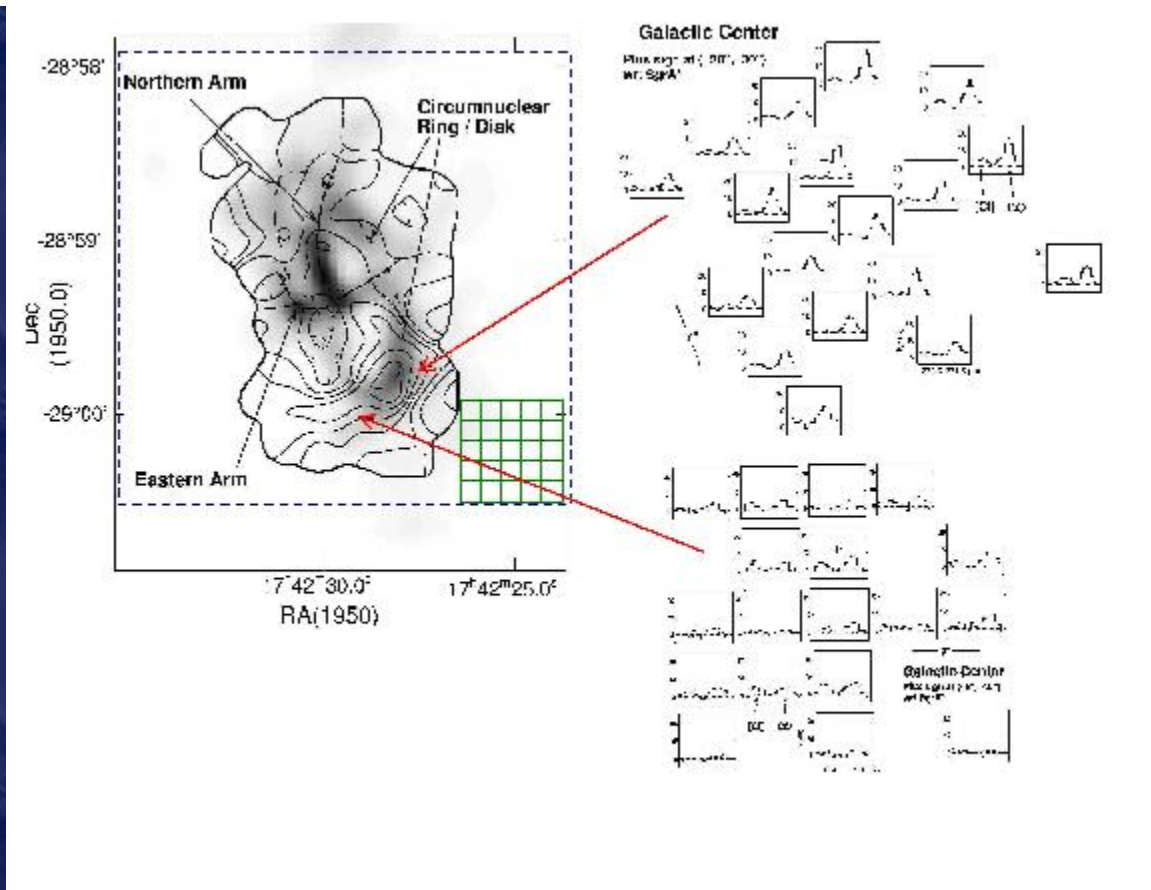


Figure 1. (left) SPIFI CO (7-6) contours (April 1999 run) overlain on a 37.7um continuum image. The inset shows our 5x5 array footprint and individual pixel sizes. Blue dashed box roughly indicates the region mapped in 2001 (right). Sample footprints from our April 2001 run with arrows indicating positions for cross-marked pixel.

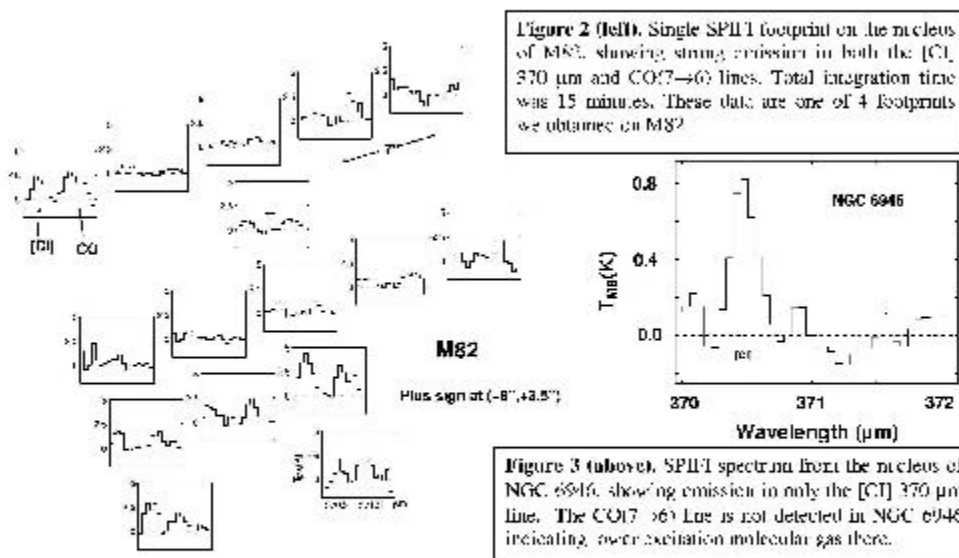
The data from our April 2001 run, is much more extensive. We made 43 distinct pointings of the 25 element SPIFI array (21 detectors operational) for about 900 distinct spectra in each line. These spectra have a velocity resolution of about 150 km s^{-1} , and cover 1680 km s^{-1} , so that both the [CI] and CO(7@6) lines are detected in one scan. In Figure 1 (right), we present two sample footprints from this data set. Quite apparent are changes in the CO(7@6) to [CI] line intensity ratio. Since the critical density for the CO line is about 300 times larger than that of the [CI] line, changes in this ratio largely reflect density enhancements (clumps or shocks) within the ring. Notice that the CO line is relatively much stronger than the [CI] line at the inner edge of the CND reflecting the intense UV fields and shocks caused by cloud-cloud collisions there. However, the CO line intensity falls off quite rapidly with radial distance from the far-IR ring. In contrast, the [CI] line is relatively weak at the far-IR ring, gets *brighter* just a few tenths of pc into the ring, and stays bright out to the furthest regions that we have mapped so far ($r \sim 3 \text{ pc}$). It is clear that the [CI] emission is not dominated by the photodissociated inner edge of the CND, but is dominated by emission from the outer parsecs of the CND. This was known from previous mapping of the [CI] 610 mm line. However, our new 370 mm observations indicate that this extended [CI] emitting gas is also quite warm: $T_{\text{ex}} \sim 100 \text{ K}$. The data analysis is still progressing, but we expect to use the line ratio map to pick out localized clumps and shocks, especially for regions where streamers entering the central cavity collide with the CND. The imaging array yields near perfect registration and relative calibration between pixels and spectral lines in a map, greatly facilitating the analysis.

From our first run, we observed the CO(7@6) line from M82 and NGC 253 – two nearby starburst nuclei. The NGC 253 data has appeared in C.M. Bradford's thesis, and will soon be submitted to ApJ. Our NGC 253 data indicates the high J emission is widespread - the line is clearly detected over most of the array footprint. Comparing our CO(7@6) map with low J maps from the literature characterizes the physical conditions of the molecular ISM. The bright CO(7@6) line indicates the emitting gas is remarkably warm ($T_{\text{gas}} \sim 180$ K), and dense, $n \sim 4 \times 10^4 \text{ cm}^{-3}$ - highly excited by the strong UV fields of the starburst. This suggests the starbursts are self-limiting, in that the effect of the large UV fields is to heat and fragment the ambient molecular ISM thereby inhibiting further star formation.

In April 2001, we obtained spectra including both the CO(7@6) and [CI] lines on NGC 253, M82, NGC 6946, M51 and NGC 4038/4039. Both lines were detected from the nuclei of NGC 253, M82 (Figure 2) and M51, while only the [CI] line was detected from NGC 6946 (Figure 3). The ratio of the lines is indicative of the excitation of the ambient interstellar medium. The [CI] line is relatively easy to excite, so that it is strong in quiescent spiral galaxies such as NGC 6946 (and the Milky Way). However, the CO(7@6) line has much higher excitation requirements and is only strong on large scales in the nuclei of starburst galaxies. The line ratio therefore traces the excitation of the interstellar medium. For starburst galaxies, the C^0/CO abundance ratio is often greatly enhanced. The [CI] 370 mm observations can ascertain the origins of the [CI] emission: strong 370 mm line emission signals PDR origins, since the gas in PDRs is warm. Cosmic ray enhancement of abundances would not lead to enhanced 370 mm line emission since cosmic rays are much less effective at heating the gas. The brightness of the [CI] lines that we observe in M82, NGC 253, and M51 favor a PDR origin.

origin.

Further information on SPIFI can be found in Bradford et al. 2002 (to appear in Applied Optics) and at our web site:



<http://www.astro.cornell.edu/SPIFI/new/spifi.html>.

ACKNOWLEDGEMENTS

Many people have contributed to the success of SPIFI. We are extremely grateful to the management and

staff of the JCMT for giving us the opportunity to bring a complicated new instrument onto the superb JCMT telescope, and for their help with logistics, emergency repairs to components of the instrument and mount, software and interfacing, and shipping and packing. We thank the Director, Ian Robson for his continued support and enthusiasm for the SPIFI project. Perhaps most important is the wonderful support we received from Wayne Holland, and Richard Prestage at the telescope during the first nights of observing in April 1999.

People involved with the instrument or observing runs include Gordon Stacey, Matt Bradford, Thomas Nikola, Laurie Hall, Jim Jackson, Alberto Bolatto, Frank Israel, Kate Isaak, Peter Ade, Jackie Davidson, Maureen Savage, Sarah Unger, and Christine Wilson. We are grateful for the GSFC arrays out of S. Harvey Moseley's group.

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Gordon Stacey

New JAC Public Science Outreach Specialist

Douglas Pierce-Price



Hello everyone. I'm the new 'Science Outreach Specialist' for the JAC, and am responsible for both JCMT and UKIRT outreach activities. If you're doing interesting science with the JCMT and would like to publicise it, or have any other queries, please do get in touch with me, Douglas Pierce-Price, at d.pierce-price@jach.hawaii.edu, 808-969-6524.

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Douglas Pierce-Price

Snow on Mauna Kea



I know this is not a science article, but this winter we've received more snow on Mauna Kea than we have for many years past. One recent storm deposited 6" of snow at Hale Pohaku, and twice this winter (so far) the white stuff was seen on the ground almost as far down as the saddle. Check out our [photo gallery](#) of recent (and not-so-recent) pictures of the summit, the telescope, and other sights. And while you're at it, why not take a [Virtual Tour](#) of the JCMT, courtesy of Robin Phillips?



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[Gerald Moriarty-Schieven](#)

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JAC Internal Science Seminars

Coming to the JCMT to observe? We'd love to hear about your current research. The JAC and Gemini now operate a joint seminar series, and with visitors from Subaru, the CSO, the IfA, the SMA, UHH, and other facilities you can be assured of a varied and interested audience. The average attendance at JAC/Gemini seminars over the past year was about 15+/-6 people.

If you'd like to volunteer to give a seminar, please contact [Gerald Moriarty-Schieven](#).

A list of those given to date this year and arranged for the future can be viewed [here](#).

If you'd like to be notified of upcoming seminars, please join the seminars emailing list. Just send [me](#) a note and I'd be happy to add your name.

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[*Gerald Moriarty-Schieven*](#)

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On-line Documentation:

All up-to-date information on the JCMT and instrumentation is maintained through links from the JCMT homepage at URL:

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NEXT ISSUE DEADLINE

The deadline for submission of science and/or technical articles for the next issue of this Newsletter is **25 August 2002**. *Please consider submitting a short article/figure of your latest result from the JCMT!* All communications regarding this Newsletter should be sent via email to Gerald Moriarty-Schieven (g.moriarty-schieven@jach.hawaii.edu).

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