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The JCMT Newsletter

Kilia I Ka Nu'U

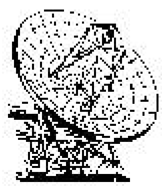
The JCMT Newsletter

Number 19

September 2002

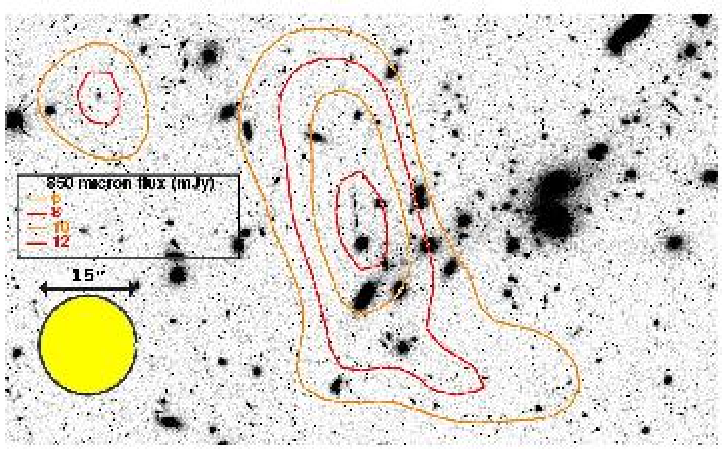
Gary Davis
Our New Director JCMT

September 2002 Issue Number 19



Kulia I Ka Nu'U

The JCMT Newsletter



A Giant Sub-mm Lensed Arc?

back to:> The JCMT Home Page

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Gerald Moriarty-Schieven

From the *NEW* Director's Desk

It is a holiday Monday morning and the office is quiet. The Sun is shining over Hilo and the sky is dappled with fluffy white clouds. From one window of my office I can see almost to the summit of Mauna Kea; from another, I gaze out over the endless expanse of the Pacific Ocean. And so begins my tenure as the new Director JCMT. With this image in mind, let me bring you up to date on recent events at the JCMT and my plans for the future use and development of the facility.

I begin, however, by thanking Ian Robson for his sterling service to the JCMT community over his 10 years as Director. Ian has been a forceful advocate for the telescope within the PPARC system and on the international stage, and has worked very hard not only to ensure its continued viability on behalf of its users, but also to map out the long-term future of the facility. His will be a difficult act to follow. I wish him the very best of success in his new post as Deputy Director of the UK Astronomy Technology Centre.

Ian described the future plans for the JCMT in the previous newsletter. Beginning in 2006, the JCMT will concentrate on wide-field astronomy with HARP-B and SCUBA-2, and will also participate in sub-arcsecond astronomy with the SMA. The goal of this transformation, while driven in part by fiscal constraints, is to ensure that the JCMT makes optimum use of its unique characteristics as the best single-dish submm facility in the world by emphasising its complementarity to ALMA. Thus the JCMT will remain a vital facility on the world stage for many years to come. My primary mandate as Director for the next five years is to manage this change and to usher in the new era of wide-field astronomy at the JCMT.

In this context, I am delighted to be able to report that the last piece in the SCUBA-2 funding jigsaw is now in place. The application by a consortium of Canadian astronomers to the Canada Foundation for Innovation for C$12.2M in support of SCUBA-2 was successful (subject to some conditions, which are currently being addressed). On behalf of the entire user community, I offer my congratulations to the consortium (of which I was a member before I accepted the Directorship!), led by Mike Fich of the University of Waterloo. This was not a straightforward exercise and the consortium worked through some difficult issues to put together an excellent proposal. A major public announcement of this award is anticipated in November. The Canadian team will be responsible for providing the warm electronics and the data reduction software for SCUBA-2, and will also make financial and personnel contributions to other aspects of the instrument, including the detector array development and fabrication; in addition, Canadian funds will be used to provide two ancillary instruments which were not part of the original SCUBA-2 design: a broadband spectrometer and a polarimeter.

The implications of this decision are profound. I anticipate that SCUBA-2 will revolutionise submm astronomy, just as SCUBA did, by providing new observational capabilities which are literally orders of magnitude better than its predecessor; and I also believe that the exciting science we expect to obtain with SCUBA-2 will constitute the strongest possible argument for the continued viability of the JCMT as the premier single-dish submm telescope in the world to 2009 and beyond.

Returning to the present, users will be aware that the JCMT was shut down for several weeks during June and July for a number of major modifications. The objectives of the work were: (a) modifications to the receiver cabin and the right Nasmyth platform in preparation for HARP-B; (b) installation and test of the K-mirror for HARP-B; (c) refurbishment of SCUBA; and (d) installation, commissioning and release of the SCUBA component of the Observatory Management Project. I am delighted to report that all of this work was satisfactorily completed: the telescope was returned to service on schedule and with all of the objectives for the shutdown period fulfilled. We are currently working with the observers and the TSSs to test and refine the new software systems. I offer my congratulations to the engineering and software teams of the JAC for their professionalism and for their management of a very complex process.

The shutdown was to be followed by 15-day period of shared-risk observations, during which the new telescope systems and each of the receivers would be recommissioned for operational use. Unfortunately, the extremely poor weather at the summit (which has persisted since April) has rendered the timely completion of these tasks impossible. The shared-risk period has therefore been extended indefinitely until the recommissioning work is completed. With any luck, this should be wrapped up by the time this Newsletter is issued; but users will be well aware that the weather is the one constraint over which we have no control.

Finally, I wish to take this opportunity to inform the community of some of my specific objectives for my tenure as Director JCMT.

The first is to enhance the reliability of the telescope system. Although this is already an imperative placed upon me by the Board, it is something I would have insisted on regardless. I am well aware of the time, effort and money that users devote to an observing run, and I am determined to minimise the occasions on which scientific programmes cannot be completed due to technical faults at the facility. Several initiatives are already underway to address this issue.

The second is to enhance the scientific productivity of the JCMT as a facility, and of the JAC as an organisation. This initiative will have some direct impacts upon observers: for instance, we will be tracking not only whether observational programmes were completed in the technical sense, but also whether scientifically useful data were obtained and whether a publication is eventually produced. I would also like to see the JAC staff, both support astronomers and TSSs, more closely involved in the science being done with the telescope, and I therefore encourage all observers to enlist the help of the JAC staff in the planning and execution of observing runs and in the analysis of data. Finally, I intend to ask all visiting observers to give a talk at the JAC before going up to HP. Although there has always been an open invitation to do so, this has traditionally been the exception rather than the rule. I hesitate to use the word "seminar" because what I have in mind is a 15-minute presentation of your observing programme: scientific rationale, observational strategy, etc. I do not believe this to be onerous, and there are many potential benefits for observers and JAC staff alike.

The third is to enhance the relationship between the JAC and the academic community from which most of its users come. One means of accomplishing this is by inviting students to spend a term or a year at the JAC, on scientific or engineering projects. The existing scheme with the University of Victoria is an excellent example of what can be accomplished in this area, and I will be looking at ways to extend the concept to other universities in the JCMT partner countries.

In addressing all of these issues, it is vital that the user perspective be taken fully into account. With this in mind, I intend (a) to interview all observers when they return to the JAC at the conclusion of their run, and (b) to spend some time at the telescope during observations. Users should also be aware that, with the change of Directorship, the Board has commissioned a review of the role of the JCMT Advisory Panel.

I conclude by assuring all observers that I intend to devote my full energies to ensuring that the JCMT maintains a standard of technical and scientific excellence second to none in the world. Now, if only I could do something about the weather.....

Gary Davis - Director JCMT

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back to:> September 2002 Newsletter Index

Click here for printable version.

Gary Davis - Director JCMT

The Nightwatchman

Edition 4

Autumn 2002

Hilo, September 1

TSS Support

During the recent shutdown period, TSSs worked on a variety of projects to help contribute to the efficiency of JCMT operations. Ed Lundin worked on a detailed organization and ordering of fault issues and troubleshooting techniques to allow for easier and more timely troubleshooting efforts. Thomas Lowe developed a lengthy functional check-out document to insure a thorough and comprehensive recovery from our lengthy shutdown period. Jim Hoge provided valuable daytime assistance during the full warm up and engineering on SCUBA. And, I worked closely with the software group as they developed the new OMP (Observation Management Project) and associated software tools to provide TSS at-the-telescope perspectives.

Other than this, TSS Support has remain largely stable and unchanged during the recent semester. In addition to Robin Phillips and Jan Wouterloot, we would like to welcome Bernd Weferling as a support scientist providing occasional operational support at the summit.

The Linux Revolution

As those of you who have visited JCMT recently may already know, the JCMT computing systems for observers (and for the TSS) have undergone substantial changes. Gone are the plodding single-display Suns running Solaris and here now are the shiny new PCs running Linux with the GNOME desktop environment and multiple flat-panel displays.

The primary observer's workstation and the continuum data reduction machine is a high performance PC with three screens known as kolea. The secondary observer's workstation is a high performance PC with two screens known as ulili. Additionally, the TSSs have a new three-headed Linux machine themselves to enable more efficient telescope operations and multi-tasking.

Most people will immediately notice the speed and screen real estate increases accompanying the new machines, but most of the programs that observers are familiar with on the old Sun-Solaris machines have been ported to Linux as appropriate. Additionally, instead of the old VAX-to-UNIX data transfer that moved observations from one disk to another before observers could reduce them, the data is now mounted read-only directly on the VAX disk and gone is the often-time-consuming transfer of data across the local network. Meanwhile, with the new improvement in JAC's summit internet connection, the frequency of data backups to downtown is being increased to offset the loss of this at-the-summit backup system. Pictures of the new control room systems can be found at the CSG (Computer Services Group) link at the bottom of the JCMT shutdown web page, to which a link is provided on the main JCMT home page. Lastly, a color printer is now installed at the summit for your at-the-telescope color-plotting needs.

The OMP

Continuum observing has obtained a new look and feel, and a whole new front-end software interface thanks to the OMP. Detailed elsewhere in this newsletter more extensively, this project promises to change the observer experience for SCUBA observing, for ACSIS observing once that instrument is delivered and commissioned, and perhaps even for DAS observing in the interim. While there has been a bit of a learning curve for both investigators and observers, commissioning and use has gone rather well considering the horrible weather that we've had since the shutdown.

This new system should bring increased efficiency of and control over the observing process. The new Query Tool will allow observers the ability to instantaneously evaluate many variables automatically to help in selecting the most appropriate and highly ranked proposal fitting the current time and weather conditions. The new Observing Tool should allow investigators a higher degree of control over his or her observations and remove the need for many at-the-telescope interpretations of proposals in the early morning in an oxygen-poor environment.

La Citation du Semestre

There is a theory which states that if ever anybody discovers exactly what the Universe is for and why it is here, it will instantly disappear and be replaced by something even more bizarre and inexplicable. There is another theory which states that this has already happened.

Douglas Adams, The Hitch Hiker's Guide to the Galaxy, 1978

Happy winter eclipse chasing (total solar and penumbral lunar)!

Jonathan Kemp

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j.kemp@jach.hawaii.edu

A new look for SCUBA observing

From the start of 2002B, SCUBA observing looks quite different as two JCMT projects (OMP and OCS) made significant software deliveries. These include:

- the JCMT OT (observation tool) that allows PIs to fully specify their observing programmes and submit them to our database for execution.
- The JCMT QT (query tool) that allows TSS and observers to query our database for the best observations given the current conditions, TAG priorities etc.
- A new unix-based scuba queue and a queue control GUI application (JCMT MON) which allows queue control, pointing source selection etc.
- The OMP Feedback system that provides cradle-to-grave project tracking for PIs and queue managers. This includes a web page for each project summarising its current state and past history, as well as automatic notification of completed observations.

In addition to these applications, we have written some other systems that the observers do not directly interact with but are necessary for observing, such as a database front end server and a scuba translator that take the encoding produced by the preparation software and translate them into the ODFs that the SCUBA acquisition understands.

Almost all the software described above is in use at UKIRT and/or will be reused for JCMT heterodyne observing in the ACSIS era. Standardising on a single codebase between all instruments on the JAC telescopes reduces the software support load which in turn releases programming effort to make further improvements.

Check out omp.jach.hawaii.edu for more information, usage instructions and access to the project feedback system.

The software was contributed by Martin Folger at the ATC and the JAC OMP team (Tim Jenness, Kynan Delorey, Shaun de Witt, Matthew Rippa, Brad Cavanaugh and Frossie Economou). Invaluable advice was contributed by Kate Isaak (MRAO) and Jonathan Kemp (JCMT) and countless other JAC staff and observers.

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back to:> Newsletter Index

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THUMPER in Semester 03A

THUMPER, a 7-element bolometer array operating at 200 microns, is expected to arrive at the JCMT in January 2003 to be commissioned during semester 03A. See the article in the March 2002 JCMT Newsletter, or go directly to the THUMPER web pages for more information on this instrument. Proposals are not being solicited for semester 03A using *THUMPER*, but potential commissioning projects may be considered. Contact Derek.Ward-Thompson@astro.cf.ac.uk for more information.

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back to:> Newsletter Index

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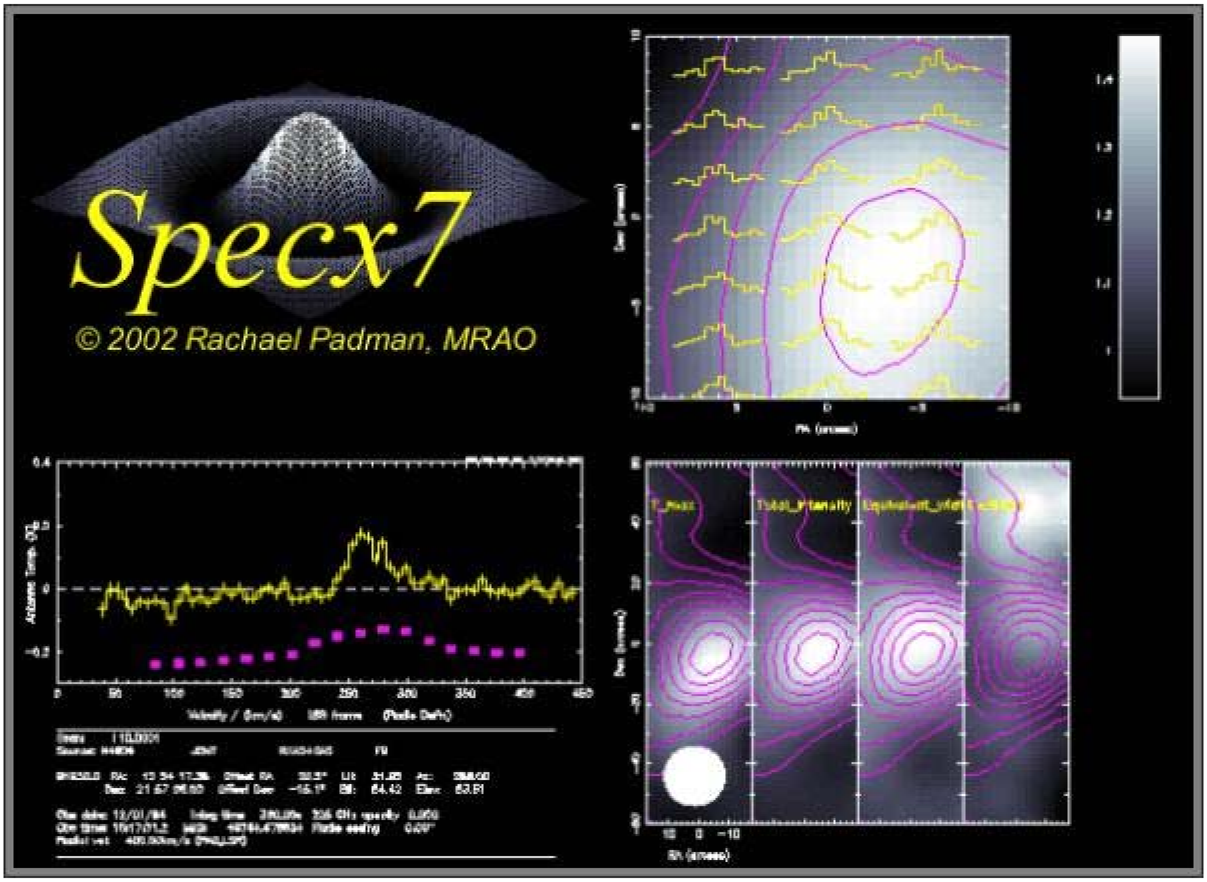
Derek Ward-Thompson - Cardiff



SPECX 7.0 for WINDOWS Released

Specx 7.0.2 is now available for download from www.mrao.cam.ac.uk/~rachael/specx. This version installs and runs on all versions of Windows, but is not yet available for other platforms. I hope that a linux port will follow relatively quickly, once I have tidied up a few things that don't yet comply with the Fortran standards.

Although users should find the look and feel quite familiar, the new version is a complete rewrite, with lots of new features. The main differences are in the use of new dynamic data structures, to remove the artificial limits on such things as length of spectra, number of subbands, size of the stack etc, and a considerable extension of the SCL scripting language, with proper procedures (which include facilities for passing and returning arguments) and additional control constructs (labels, go-tos and a "break" command). Multi-dimensional arrays and functions are also supported. Other significant new features include:

- The ability to plot in multiple windows, and panes within windows.
- A greater range of plot options, including scatter plots and error-bars.
- A facility for automatically re-gridding two spectra to a common sampling before adding or averaging them (so that you could build up a spectral-line survey simply by repeated averaging,

for example).
  - A range of commands for creating and annotating plots (adding titles, arrows etc, and plotting arrays as line plots or images).
  - Much more versatile mapping, which can easily accommodate large volumes of irregularly-gridded data.
  - Integration of grid-map with other mapping plot types, and the addition of a simple "movie" facility in "channel-map".
  - A "Select" command to select a subset of the spectra in a file or map for further processing.
  - Better handling of spectral-axis units.
  - A significant speed increase, by a factor of 50 or so in the command language, and a factor of 5 to 10 in the reduction operations.
  - Improved error handling, and html documentation.

The "splash screen" from the new version is shown below, illustrating several of these new features.

Specx7 is based on three portable subroutine libraries: Fitsio, for all file handling; Pat Wallace's SLALIB for astrometric functions, and Tim Pearson's PGPLOT for graphics (with a Windows driver written by Charles McLachlan at MRAO). In particular, all files (data, map and dump) use a version of FITS binary tables, and are portable between platforms. I have also used Remo Tilanus's C version of the GSD library, but have emulated the few Starlink utility routines used within that, rather than attempt to port the whole slew of Starlink libraries.

Of course, I recognize that the "Windows-only" restriction at the moment might make this unattractive to some. But if you would prefer to work in a Windows environment anyway, or don't usually use Specx native file format much, then you will probably benefit by making the change.

While the current version (7.0.2) is still really a "beta", I have been testing it pretty hard using real-life data (including a map containing 70000 spectra), and it appears to work pretty well. It would really be helpful at this stage, however, if other people would try it out and then send me feedback. At this stage I am concentrating on ensuring that the release is complete (i.e. has all the functionality of v6.7) and is as bug-free as possible. I have lots of ideas for new features, but those not already included, will probably have to wait until v7.1 at this point.

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back to:> Newsletter Index

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Rachael Padman - Cambridge

6th August, 2002

Back to: The JCMT Newsletter Index

PATT Application Deadline

Deadlines for receipt of all JCMT applications for semester 03A is midnight:

30 September 2002

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**

Back to: The JCMT Newsletter Index

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Gerald Moriarty-Schieven (gms)

JCMT image here

Weather Statistics for Semester 02A

The following tables present the weather loss for semester 02A. Take a deep breath before looking further. The anomalous values for July 2002 are due to the shutdown. For losses dut to faults see the 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	9.3	160.3	35.8	135.5	30.2
Mar	496.0	12.3	261.5	52.7	158.4	31.9
Apr	424.0	16.8	177.4	41.8	66.0	15.6
May	484.0	3.0	367.8	76.0	249.9	51.6
Jun	470.0	18.5	115.3	24.5	48.8	10.4
Jul	0.0	0.0	0.0	0.0	0.0	0.0
Totals	2322.0	59.9	1082.3	46.6	658.6	28.4

Iain Coulson

JCMT shutdown in the summer of 2002

Plans are firming up for a service shutdown of the JCMT in the summer of 2002. Why are we having a service shutdown? One issue to be addressed by the shutdown is the problem of the sticking filter drum on SCUBA. This problem started in December 1999, making it impossible to use any other filter than the 850/450-wideband combination. Repairing the filter drum will take SCUBA out of action for several weeks and is not risk free. ITAC has weighed the scientific motivation for a repair against the outage and risk. It was decided, at the June 2001 ITAC meeting, to do the repair during the summer 2002. During the shutdown, we will also replace the bad indium seal. Other SCUBA work under discussion are fridge repair/maintenance, replacing the 850 micron filter with new edge filter, wide-band 850-750 micron filter, new 850 micron array feed horns and fixing broken or noisy pixels.

We also need to shut down the telescope in order to do preparation work for the B-band array HARP-B. The array has a K-mirror for image rotation that will be located in the cabin. In order to install the K-mirror the cabin needs to be modified. Further, all helium lines for the closed-cycle coolers in the cabin need to be rerouted. The work will involve electrical welding as well as cutting metal burs. Due to the risk of damaging the SIS junctions and receiver optics, all heterodyne receivers will be removed from the cabin during this work. The antenna will be immobilized during this work stopping all observations allowing for extended working days to complete the task as quickly as possible - making the antenna ready for SCUBA observing each night would be very inefficient if even possible.

To minimize the loss of SCUBA observing time we plan to overlap the shutdowns as much as possible. We have insufficient staff to do all work in parallel. Other factors affecting the planing is availability

of ATC staff needed for the SCUBA work and avoiding other labor intensive work at the JAC such as the move of Michelle to Gemini. The current plan, which not is final, is outlined below.

June 13th SCUBA work starting with warmup.

June 24th Heavy engineering starts, heterodyne receivers removed and antenna is closed.

July 15th SCUBA work finished and cool-down starts.

July 22nd Heterodyne receivers returned to cabin, pumping and preparation for cool-down starts.

July 23rd SCUBA observing starts - still extended day work.

July 26th Extended day work ends - 16 hours observing starts.

Aug 2nd All instruments in operation.

The final schedule will depend on the amount of SCUBA work attempted as well as need for contingency time.

Per Friberg

2001/08/30

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back to:> [September 2001 Newsletter Index]

Click [here] for printable version.

JCMT image here

Weather Statistics for Semester 01B

The following tables present the weather loss for semester 01B. For losses dut to faults see the 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

Back to: The JCMT Newsletter Index

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.

Back to: The JCMT Newsletter Index

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Gerald Moriarty-Schieven

JCMT image

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 Trec(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

Please address any comments, suggestions or requests regarding this Web page to Per Friberg

Updated: 28 July 2003

Lethbridge Fourier Transform Spectrometer

The Lethbridge FTS will not be available during semester 03A.

Further information about the instrument is available at:

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

Back to: The JCMT Newsletter Index

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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" (~ 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. Recent science highlights using the instrument were published in the March 2002 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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back to:> Newsletter Index

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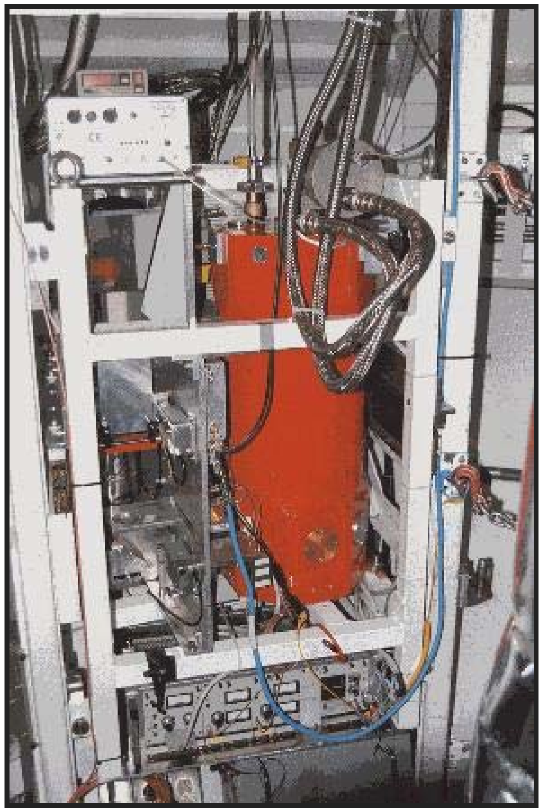
Gerald Moriarty-Schieven

Back to: The JCMT Newsletter Index

Max-Planck-Institut 800 GHz Instrument



The MPIfR/SRON heterodyne spectrometer (MPIRE) for the 350 micron atmospheric window (E-band) was 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 GHz<0.05). Preliminary analysis yields a main beam efficiency eta_mb~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.

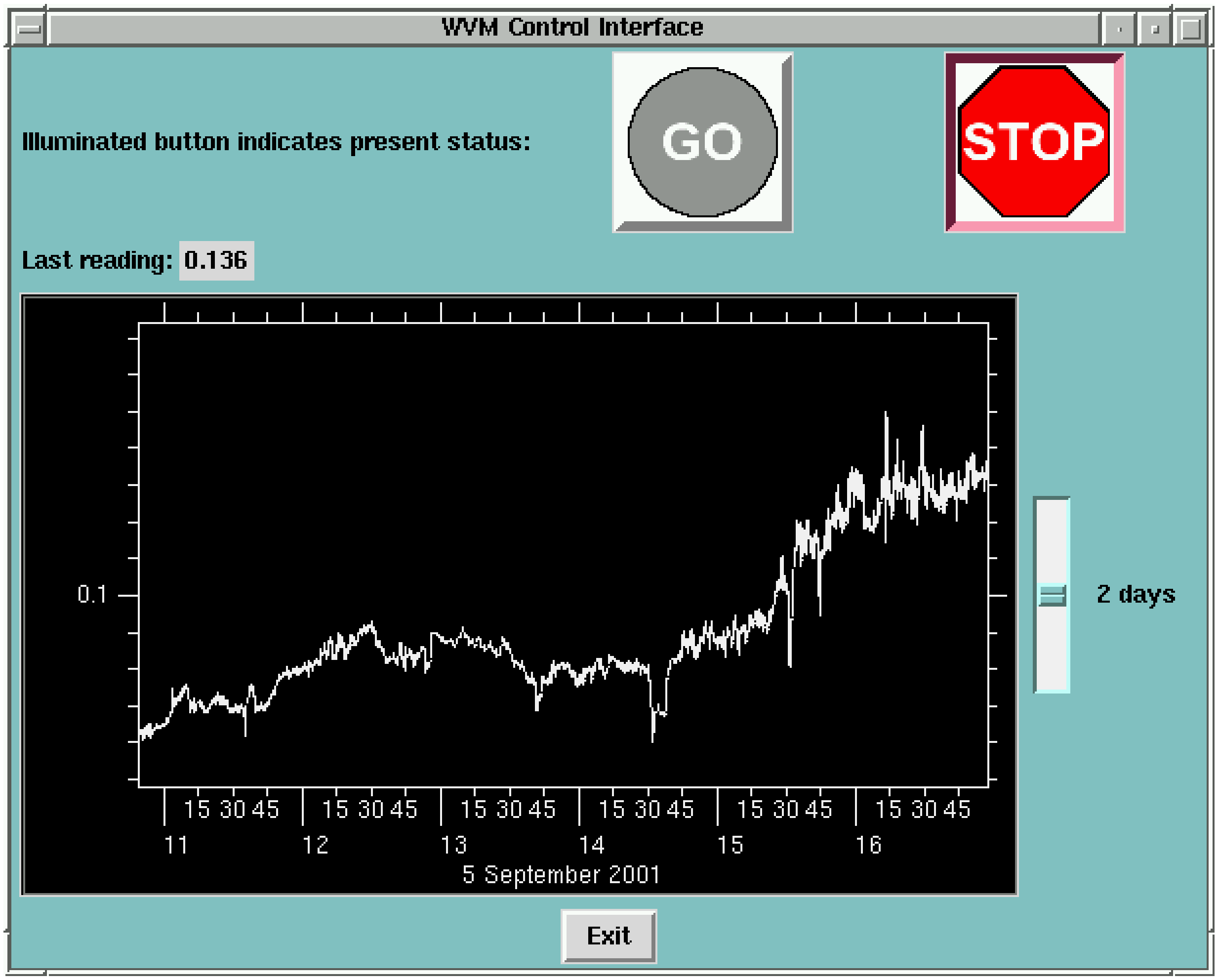
Back to: The JCMT Newsletter Index

The JCMT 183GHz WVM

Since the summer of 2001 the JCMT has been reguarly 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 exactyl 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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back to:> Newsletter Index

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Robin Phillips

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 2001, some 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 March 2002 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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back to:> Newsletter Index

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Ian Robson

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 reciever A in tau-cso = 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 tau is 0.15 you get a certain rms in one hour.
>
> If tau is 0.20 you'll get the same rms in 1.4 hours
>
> If tau is 0.25 you'll get the same rms in 2.0 hours
>
> If tau is 0.30 you'll get the same rms in 2.6 hours
>
> If tau is 0.35 you'll get the same rms in 3.2 hours
>
> If tau 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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back to:> Newsletter Index

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Gerald Moriarty-Schieven

A SCUBA Galaxy in the Protocluster around 53W002 at z=2.4

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Rob Ivison, Jason Stevens
Astronomy Technology Centre, Edinburgh

Jim Dunlop
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Bill Keel
Department of Physics & Astronomy, University of Alabama,

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Introduction

The extreme luminosities the dusty galaxy population which contributes the bulk of the extragalactic background in the far-infrared and submm has emphasised the importance of dust-obscured activity in the early evolution of massive galaxies and black holes (Blain et al. 1999; Cowie et al. 2002). The majority of the dusty, active systems detected by SCUBA appear to lie at z>1, their typical bolometric luminosities are 10^{11}-$10^{13}L_o$ and their space densities are ~10^{-4}Mpc^{-3}, 2-3 orders of magnitude higher than similar luminosity galaxies at z~0. However, little is known about the types of environment which these galaxies inhabit. Similar luminosity, dusty systems in the local Universe are typically found in low-density regions and they avoid the dense cores of rich clusters of galaxies (Tacconi et al. 2002). The situation is predicted to be very different at high redshifts where, if they truly represent the progenitors of massive ellipticals, the SCUBA galaxies should be clustered in the highest density regions (Ivison et al. 2000b).

Due to the small samples available in the submm waveband observational evidence of this clustering is tentative at the present-time (Scott et al. 2002; Webb et al. 2002). Nevertheless, there are suggestions that SCUBA galaxies are strongly clustered, in particular associations of SCUBA galaxies with other classes of clustered high-redshift sources, such as Lyman-break galaxies or X-ray sources, have been found (Chapman et al. 2001; Ledlow et al. 2002; Almaini et al. 2002). A more direct approach to tackle this question has been undertaken by Ivison et al. (2000b) in a targetted SCUBA survey of regions around high-redshift, powerful AGN. These are expected to preferentially inhabit high-density regions, a prediction which has some observational support from the discovery of excesses of both Extremely Red Objects and Ly-alpha emitters around some high-redshift radio galaxies. The first results from the Ivison et al. (2000b) survey show a significant overdensity of SCUBA galaxies around the signpost high-redshift AGN, but confirming this association with redshifts for the SCUBA sources has proved difficult.

One of the fields covered in the Ivison et al. (2000b) survey is that surrounding the z=2.39 steep-spectrum, narrow-line radio galaxy 53W002 (Windhorst et al. 1998). This region is especially interesting as it has been shown to contain an over-density of compact, Ly-alpha emission-line galaxies at z~2.4 (Pascarelle et al. 1996, 1998; Keel et al. 1999). Nine of these emission-line galaxies have been spectroscopically confirmed as companions to the radio galaxy, with a velocity dispersion of ~400 km s^{-1} and a spatial extent of ~4Mpc (Keel et al. 1999). Here we report on the SCUBA observations of the 53W002 field which uncover four luminous, submm galaxies. By matching the submm source position using an astrometrically-precise 1.4-GHz map we show that one of these sources is coincident with a Ly-alpha-selected galaxy at z=2.39, 330kpc awy from the radio galaxy in projection. This confirms the presence of ultraluminous, dusty galaxies in the over-dense structure around 53W002 at a look-back time of 11Gyrs (we adopt a cosmology with q_o=0.5, and H_o=50kms^{-1}Mpc^{-1}). This work is described in full in Smail et al. (2002b).

Observations and Reduction

We observed a ~2.3'-diameter field centered on 53W002 at 450- and 850-um during 2001 March 3-6 using the SCUBA (Holland et al. 1999) on the James Clerk Maxwell Telescope (JCMT). The conditions were good and stable for the four nights when data was taken, with an 850-um opacity measured every hour of 0.12-0.23 for the first three nights, rising to 0.35 on the final night. The total exposure time was 33.3ks. The 450- and 850-um maps were created using SURF (Jenness & Lightfoot 1997). In order to extract reliable source positions and flux densities, the maps were deconvolved using the symmetric -1, +2, -1 zero-flux beam (which arises from chopping and nodding) and a modified version of the CLEAN algorithm (Hogbom 1974) as described by Ivison et al. (2000b). This process produces a restored map at the native resolution of the JCMT, 14" FWHM, but without the negative sidelobes from the chopping of bright sources.

For the radio observations we employed the VLA in B configuration, obtaining a total of 3h of useful integration during 2001 May 14 and May 17, the resulting map has a noise level of 30uJy beam^{-1}, with a 5.3" × 3.7" beam.

Our analysis also exploits archival *Hubble Space Telescope* (*HST*) imaging of the 53W002 field in both the optical (WFPC2) and near-infrared (NICMOS), comprising three broadband exposures: 57.6-ks in F450W (B_{450}), 27.2-ks in F606W (V_{606}) and 20.4-ks in F814W (I_{814}), as well as a 40.5-ks exposure in the F410M medium band (which isolates redshifted Ly-alpha at z~2.4). The acquisition and reduction of the NICMOS imaging, 2.4-ks integrations in the F110W (J_{110}) and F160W (H_{160}) filters, is described in detail by Keel et al. (2002).

Near-infrared spectroscopy of several galaxies in the field of 53W002, in particular object #18, was obtained by Motohara et al. (2001a,b). These observations used the newly commissioned OH-airglow Suppression Spectrograph (OHS; Iwamuro et al. 2001) and Cooled Infrared Spectrograph and Camera for OHS, CISCO (Motohara et al. 2002) on the 8.2-m Subaru Telescope. A total of 4.8ks of integration in the K-band was obtained on the galaxy on 1999 May 3-4 with CISCO and 8ks in JH with OHS and CISCO on the night of 1999 May 21. An initial analysis of this spectrum is described in Motohara et al. (2001a).

Analysis and Results

We detect four significant sources in the 850-um SCUBA map of the 53W002 field above a 4-sigma limit of 3.7-mJy, this represents a modest excess over the blank-field expectation of 2 sources at this flux limit. One of the submm sources (SMMJ17142+5016), with an 850-um flux of 5.6+/-0.9 mJy, lies 1.3" from a 260-uJy radio source. Using the positions of other radio sources in the field we comfirm that the radio emission arises within 1.0" of an optical galaxy identified as #18 in Pascarelle et al. (1996). We conclude that #18 is the likely counterpart to SMMJ17142+5016 and in the following discussion we identify the galaxy as

SMMJ17142+5016#18.

SMMJ17142+5016#18, is one of the brightest of the ~14 Ly-alpha emission-line sources detected at z~2.4 in a narrow-band imaging search around 53W002 (Pascarelle et al. 1996, 1998; Keel et al. 1999, 2002). As Figure 1 shows the galaxy consists of pair of components separated by 0.6" (4.7Kpc at z=2.39). We compare the spatial distribution of the high-surface brightness Ly-alpha emission (from the F410M image) and UV continuum (given by the J_{110}-band, although this includes a small contribution from [OII]) in Figure 1b. This shows that a large fraction of the Ly-alpha emission from the system arises in the northern component, even though the underlying continuum in this feature is weak. This component may represent either lower-mass companion, tidal debris or scattered light from an obscured AGN. Deeper, ground-based Ly-alpha imaging of this galaxy by Keel et al. (1999) shows that it also possess a very extended Ly-alpha halo, >50kpc. The restframe optical morphology of this galaxy is thus strongly reminiscent of other well-studied SCUBA galaxies, showing merger/tidal features (Ivison et al. 1998, 2000a) which are probably related to the triggering of the ultraluminous activity in this system.

The restframe UV spectrum published by Pascarelle et al. (1996) shows a strong, but relatively narrow Ly-alpha line, weak CIV and possibly NV, confirming its redshift as z=2.393. We identify a number of strong emission lines in the OHS spectrum of SMMJ17142+5016#18 including H-alpha, H-beta, [OII]3727, [OIII]4959, 5007. All the lines are unresolved at the modest resolution of OHS ($<1500 kms^{-1}$) and the [OIII] lines are particularly strong, the spectral properties are thus very similar to those of a Seyfert-2 (Motohara et al. 2001a).

Taking the 850-um flux of SMMJ17142+5016 and assuming a dust spectrum with T_d=38K and Beta=1.5, we estimate a dust mass of $\sim 10^8 M_o$, and a bolometric luminosity of $(8+/-2)\times 10^{12} L_o$. The presence of an AGN obviously provides the opportunity for some fraction of the far-infrared luminosity to come from AGN-heated dust and, as with z~0 ULIRGS, it is difficult to disentangle the contributions from star formation and AGN-heating to the overall SED. The existence of a large mass of dust, $10^8 M_o$, suggests that massive star formation has occured, while the lack of X-ray detections for the general SCUBA population (Almaini et al. 2002), along with the constraints on AGN luminosities from a few well-studied SCUBA galaxies (e.g. Frayer et al. 1998; Bautz et al. 2000) both hint that only rarely does the AGN completely dominate the bolometric output from typical, luminous submm-selected sources. Hence we convert the observed bolometric luminosity into a star formation rate for $>5M_o$ stars of $\sim 750\ M_o yr^{-1}$ (Condon 1992), or $\sim 4\times 10^3 M_o yr^{-1}$ accounting for stars with masses of $>0.1M_o$ using a Salpeter IMF. Even allowing for a dominant AGN-heated component, these estimates still suggest that the galaxy is forming stars at a rate of $\sim 10^3\ M_o yr^{-1}$ - a substantial star burst.

Discussion and Conclusions

To summarise: we confirm the identification of SMMJ17142+5016#18 as an ultraluminous infrared galaxy at z=2.4, within the protocluster containing the radio galaxy 53W002. The compact, southern component of SMMJ17142+5016#18 appears to host a Seyfert-2 nucleus, while the extended emission to the north and east is most easily explained as tidal debris which is ionised by either local star formation or radiation from the AGN. Perhaps the most interesting feature of SMMJ17142+5016#18 is the extended Ly-alpha halo around this galaxy (Keel et al. 1999, 2002). This low-surface brightness features is on a much larger scale than the high-surface brightness Ly-alpha emission in Figure 1 and extends out east from the galaxy at least 6"

(50kpc). The combination of strong submm emission and an extended Ly-alpha cloud is somewhat surprising, given the propensity for dust to absorb Ly-alpha photons, although it has been seen before (Chapman et al. 2001). Taniguchi & Shioya (2001) have suggested that this phenomenum arises from an extended superwind driven by a highly-obscured starburst, the wind then shocks and ionises the gas halo which surrounds the system (Chapman et al. 2002). This model can explain several properties of these Ly-alpha halos (although other processes are also feasible, see Chapman et al. 2001 and Francis et al. 2001) and hence deserves continued investigation, in particular studying the kinematics of the extended Ly-alpha emission around SMMJ17142+5016#18 using an integral-field spectrograph on an 8-m class telescope may identify the dynamical signatures of a superwind.

Finally, we note that the confirmation of a luminous SCUBA galaxy in a protocluster environment strengthens their associated with the formation phase of the massive ellipticals, which dominate rich clusters at the present-day. Moreover, it appears that SMMJ17142+5016#18 contributes significantly (compared to the Ly-alpha-selected population) to the star formation occuring in the structure around 53W002. We can estimate a crude lower limit to the star formation density in this region, taking the rate calculated above and assuming SMMJ17142+5016#18 is the only ultraluminous galaxy in the entire structure, which conservatively contains a volume of $4\times4\times4\mathrm{Mpc}^3$ (Keel et al. 1999), giving a star formation density of $>60M_o yr^{-1}Mpc^{-3}$. Even allowing for a significant contribution from the AGN to the bolometric luminosity, this is still one to two orders of magnitude higher than the mean star formation density at this epoch (Smail et al. 2002a). This is a higher contrast than the 2-3× overdensity of Ly-alpha emitters in this region (several of which are also AGN, Keel et al. 1999) and suggests that vigorous, obscured star formation may be enhanced in the protocluster environment. The intense winds and strong radiation fields produced by this activity (which may be the cause of the extended Ly-alpha emission around this galaxy) will have profound consequences for the evolution of the other galaxies within this structure.

Acknowledgements

We thank Fumihide Iwamuro and Toshinori Maihara for obtaining the OHS spectra of SMMJ17142+5016#18, Clare Jenner for help with the SCUBA survey and Ian Waddington for the NICMOS imaging. We are indebted to all staff members of the Subaru telescope, NAOJ, who helped with the OHS observations. We acknowledge useful conversations with Andrew Blain, Scott Chapman, Cedric Lacey and Alice Shapley, as well as support from the Royal Society (IRS), the Leverhulme Trust (DGG, IRS) and PPARC (JSD, JAS).

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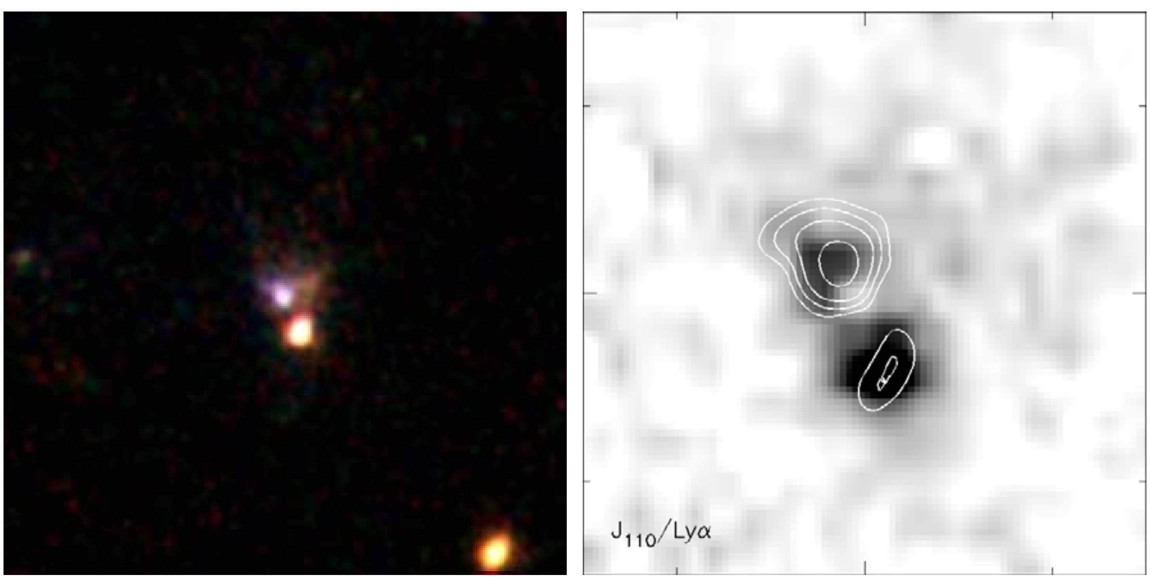

Figure 1: Two images demonstrating the varied morphology of SMMJ17412+5016#18 in the restframe optical/UV. These show a 9"× 9" (70kpc at z=2.39) true-color representation constructed from the *HST*/WFPC2 $B_{450}V_{606}I_{814}$ imaging (left) and on the right a 3"× 3" view which contrasts the morphology of the J_{110}-band, restframe near-UV continuum emission (shown as a grayscale) with the morphology in the F410M filter which is dominated by the Ly-alpha emission and is shown as a logarithmic contour plot. From these images we see that the optical counterpart to SMMJ17412+5016 comprises a compact red component

to the South and a more diffuse blue structure to the North-East with an extension to the West. At z=2.39, the K-band magnitude of SMMJ17142+5016#18 corresponds to an apparent magnitude of M_V~-23, however, its present-day luminosity depends critically on the competing effects of current dust extinction and subsequent star formation and hence the z=0 absolute luminosity of this galaxy is extremely uncertain.

Back to: The JCMT Newsletter Index

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Ian Smail - Durham

A 'Generic' Interstellar Magnetic Field?

Jane Greaves & Wayne Holland

(UK Astronomy Technology Centre)

SCUBA polarimetry has been enormously successful in mapping magnetic fields in sources ranging from pre-stellar cores to the Galactic Centre. With this wealth of information, a question arose: is there such a thing as a 'typical' interstellar magnetic field? We decided to try and pick a region in our Galaxy that is subject to all the important processes, i.e. in the vicinity of a supernova remnant, buffeted by a major star-formation region, exposed to interstellar radiation, etc. In summer 2001 we had time to observe exactly such a region, the AFGL 333 cloud filament - this lies between the W4 SNR and W3 star-forming complex, but as yet has no young stars itself.

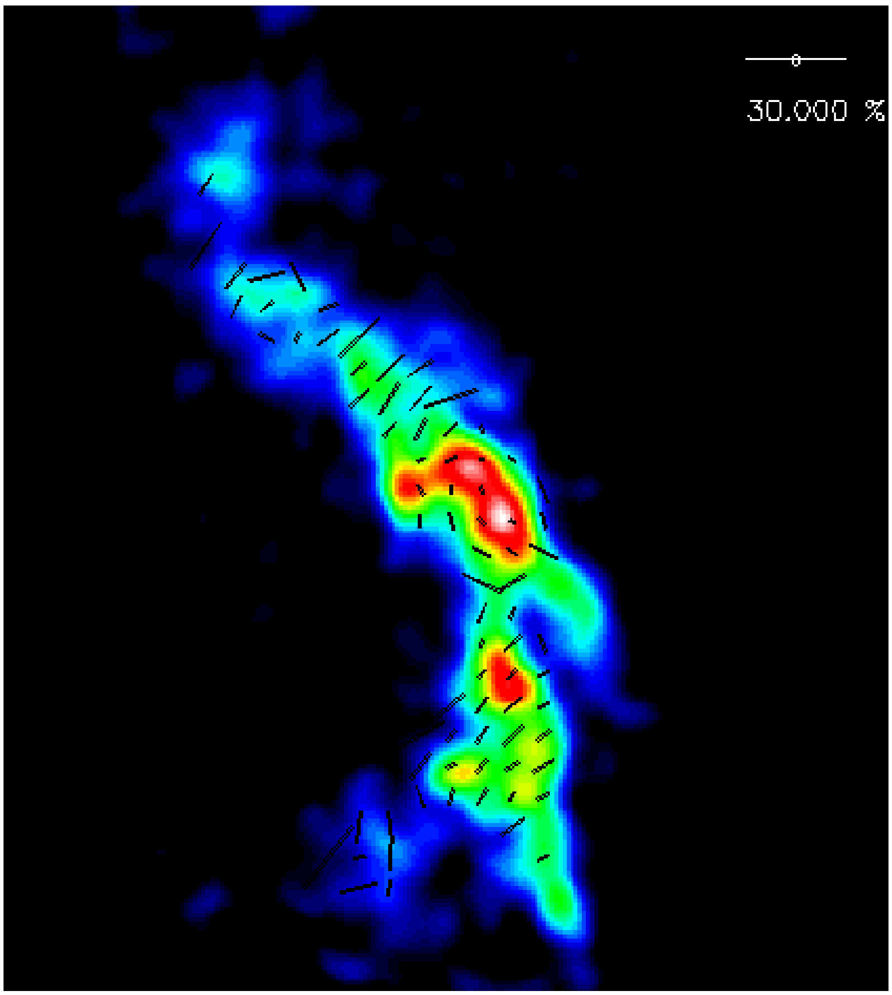
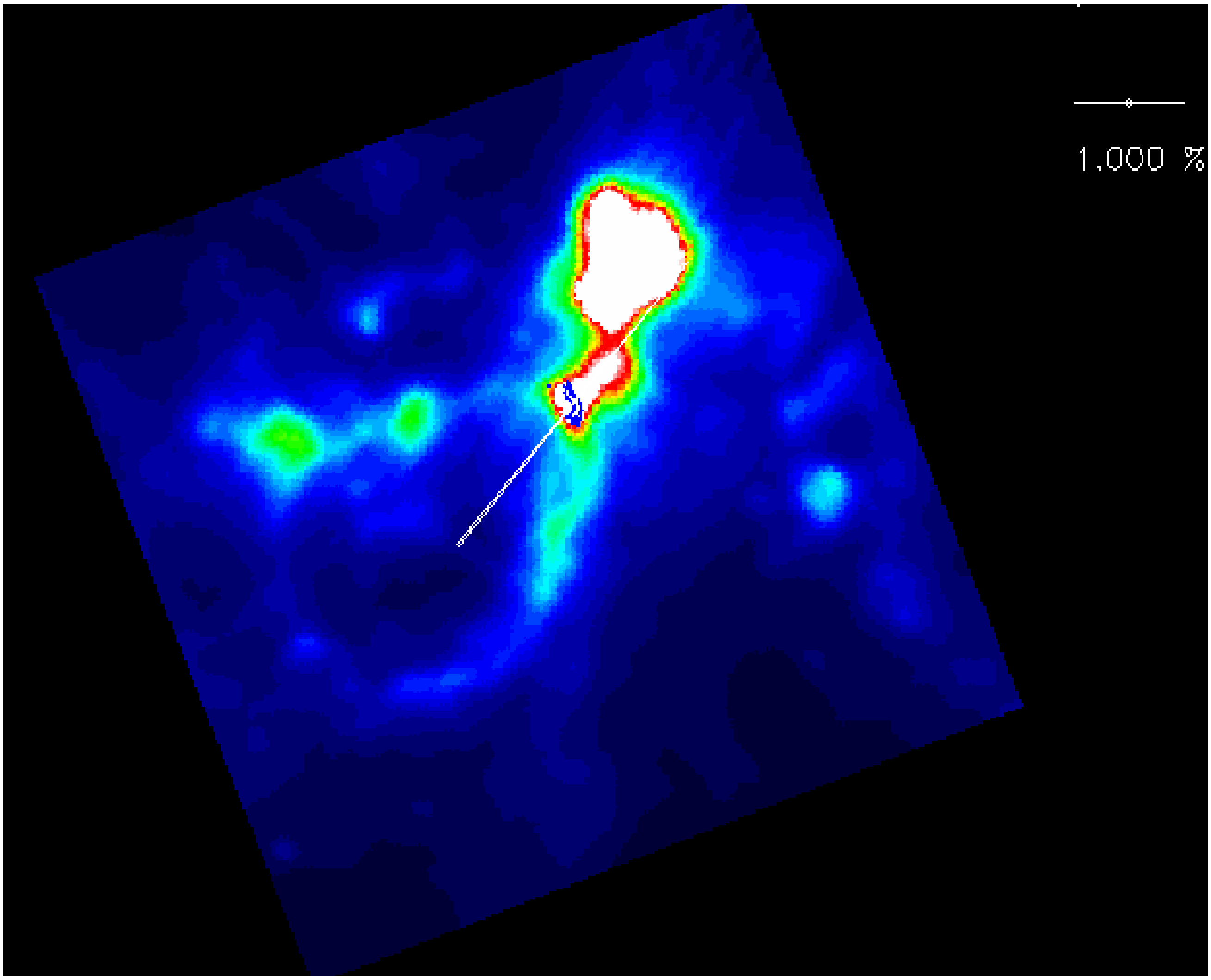
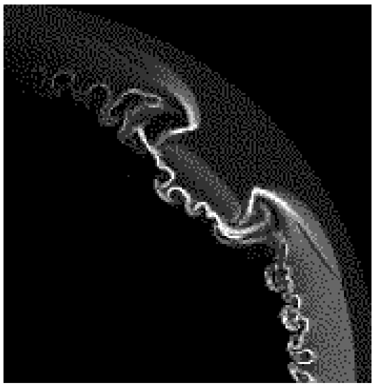


Figure 1 shows the 850 micron polarimetry results, superimposed on a scan map of the AFGL 333 filament, which is about 8 arcmin long (about 6 parsecs at 2.5 kpc distance). The vector lengths are proportional to polarization, and the directions point along the magnetic field. Two things were immediately very surprising about this image. Firstly, the polarization is high, with a mean of 6.5% - this exceeds the 3.5-5% observed in nearby star-forming clouds (see the series of recent papers by Brenda Matthews et al.). A high polarization suggests the magnetic field is unusually organised, even though the greater cloud distance means we are observing over larger scales. Secondly, there is a very clear dominant field direction, running south-east to north-west - but where there is a brighter peak the vectors start to curve. This shows up especially well for the 'magnetic wrapper' around the central double core. So our observation of a 'generic' molecular cloud has in fact shown a magnetic field structure quite different from all the gallery we have for other clouds!

Figure 2 shows the results in a wider



context - the colour scale shows the IRAS 100 micron image over about 130 pc, including the huge shell of the SNR W4, and the W3 complex (in white, saturated on this scale. The blue 'worm' is the outline of the filament mapped with SCUBA, and the single vector is the average of all the vectors shown in the previous figure. It's obvious that this points very close to the centre of the SNR, which suggests that the supernova explosion was the dominant force establishing the magnetic field in our 'generic' filament. A model for a magnetic SNR-cloud interaction was discussed by Jun & Jones (1999; ApJ 511, 774), who found that the field is dominantly radial where it is stretched out along expanding fingers produced by Rayleigh-Taylor instabilities. Although strictly this is for a specific initial situation (diffuse cloud, linear field…), there is striking resemblence of some of their model results (Figure 3, showing magnetic intensity) to our magnetic field map!



So is the field initially present in a cloud a highly-organised one established by the very large-scale environment? And how does this turn into the much more structured fields seen in star-forming cores? In AFGL 333 the field seems to be streaming out from the supernova origin and maybe getting wrapped around denser (starless) cores, but we need to revisit the theoretical models to see if this agrees with the energetics involved. Observations are the key, however, in piecing together the still largely mysterious role played by magnetic fields in the clouds forming the next generations of stars.

A GIANT SUB-MM LENSED ARC?

Douglas Scott[1], Colin Borys[1], Scott Chapman[2], Greg Fahlman[1] and Mark Halpern[1]

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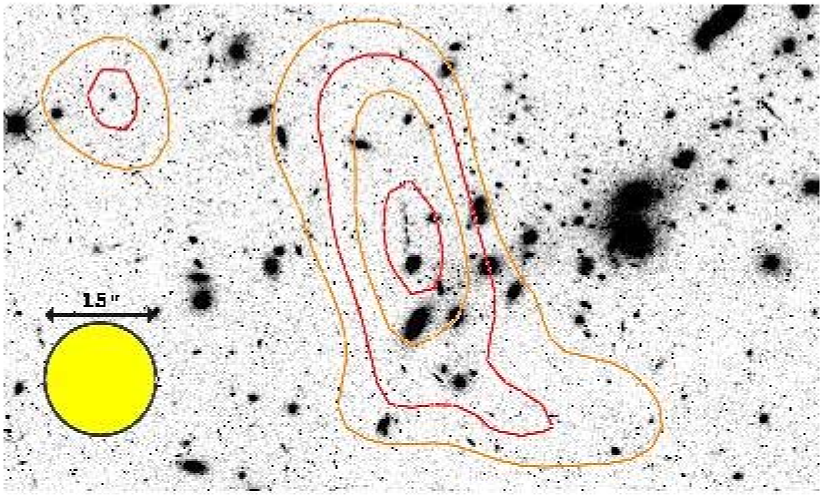

We have discovered what appears to be a giant sub-mm arc, which is coincident with, but much more extended than, a previously known optical arc in the lensing cluster MS0451-03. The figure shows 850 micron SCUBA contours overlaid on an HST image, with the lensed galaxy clearly visible. Without higher resolution sub-mm imaging it is impossible to determine how many separate objects (or images of objects) are contributing to the SCUBA emission. However, the extended ridge of emission lies directly along a portion of the Einstein ring for this cluster, which gives a striking visual demonstration of the reality of gravitationally lensed amplification for sub-mm sources. There can be no doubt that the source of the sub-mm emission lies considerably beyond the z~0.5 of the cluster.

This image also demonstrates that not all cosmological observations with SCUBA are at minimal signal-to-noise levels; this single map may in fact contain more total flux than any other "blank field" which has been observed with the JCMT. (See full size image for contour levels.) The SCUBA contours are derived from a combination of jiggle-map data taken with different chop throws and directions, and come from a map made using direct matrix inversion of the difference data. This approach was necessary because of the strong extended emission in the map, which otherwise was partially chopped out. This is the first time such a technique has been applied to SCUBA data.

For those interested in the data analysis, it's worth giving a little more detail (and others should skip this paragraph!). The basic issue is how to deconvolve the off-beams when making maps with SCUBA. The standard method (for scan-maps at least) is to approximate a series of chops as samples in Fourier space. A better approach is to iteratively solve for the underlying map which, when chopped, gives the actual data. And the the direct method is to invert the matrix of differences in order to obtain the unchopped map. None of these approaches work well unless there are enough sets of different chops in the first place to properly constrain the map (or alternatively so that the matrix is not singular). For jiggle-maps an iterative method will of course work, but in fact the total number of pixels is small enough that there's no need, since direct inversion can be performed. There are no more than around 2000 pixels in a single jiggle image, and a 2000x2000 matrix is small enough to directly invert on even a modest workstation. There are some complications to do with how one deals with the noise, with the DC level and with pixels which are off the main map, but these can all be dealt with, and are discussed in a forthcoming paper on our SCUBA observations of MS0451-03.

The lensing amplification through the cluster allows for detailed study of intrinsically fainter sub-mm sources than are possible in the field, and make follow-up observations easier in other wavebands. Existing Chandra X-ray data for this cluster, together with new near-IR imaging are in the process of being analysed. This may help towards determining the nature of these particular sub-mm sources, as well as understanding the importance of lensing for SCUBA galaxies in general.

Douglas Scott - UBC

A SCUBA Survey of the W3 Giant Molecular Cloud - Initial Results

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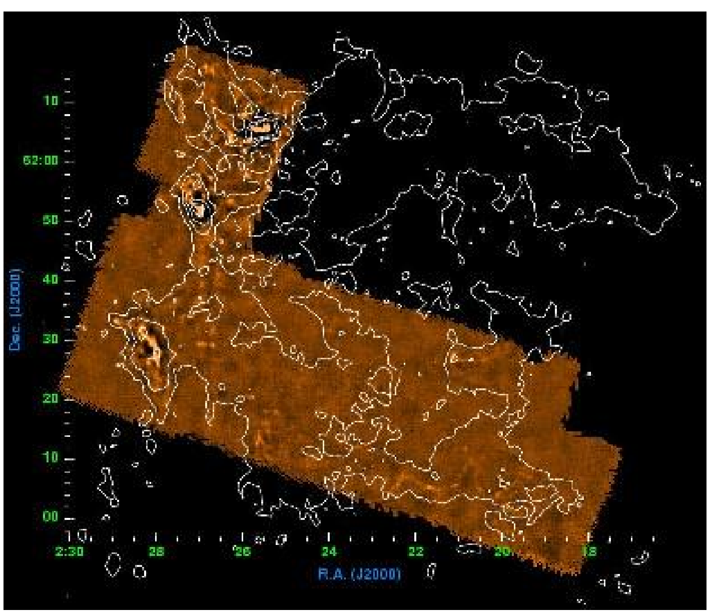
Molecular Clouds are the birthing grounds from which nascent stars emerge. Whilst a paradigm for isolated low-mass star formation (SF) has been developed - the "Standard Model" (Shu, Adams & Lizano 1987, ARA&A, 25, 23) - this model's applicability to massive SF is uncertain at present. Indeed most low-mass stars actually form in clustered regions of high-mass SF (e.g Clarke et al. 2000, Protostars and Planets IV, 151).

Massive protostars produce strong winds, outflows and a considerable UV photon flux - these phenomena will drastically alter the physical conditions and structure of the surrounding natal cloud material. Two possible outcomes of these complex feedback effects are envisaged:-

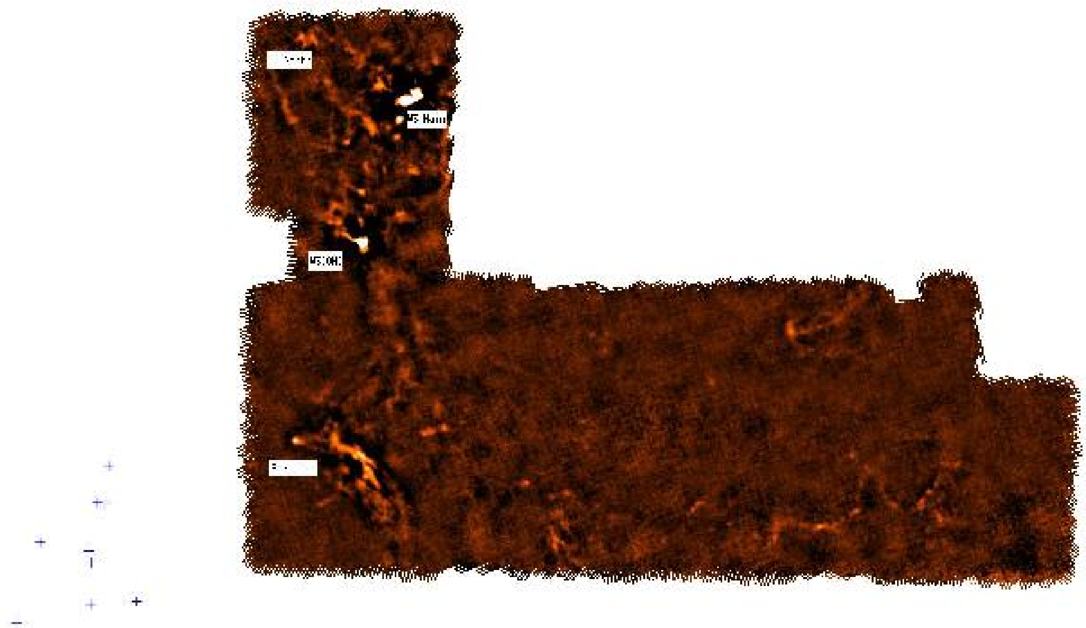
- Further induced SF, initiated by the compression of molecular material.
- Suppression of SF, due to cloud disruption.

The current generation of SF models (e.g. Bate et al. 2002, MNRAS, 332, L65-L68) are tackling SF within the context of a dynamic clustered environment. Surveys of Giant Molecular Clouds (GMCs), the sites of cluster formation, will provide the observational constraints for these theoretical models.



We have recently completed data reduction for a ~3000 arcmin^2 survey of the W3 GMC at 850 microns using SCUBA's scan-mapping mode. W3 is located in the Perseus spiral arm at a distance of 2.4 kpc and comprises some 10^5 solar masses of molecular cloud material spread over a 60 pc region (Lada et al. 1978, ApJ, 226, L39). It contains a number of young HII regions and newly formed complexes of massive stars; W3 Main, W3 North, W3 (OH) and AFGL 333. At 850 microns SCUBA's resolution is 14" (FWHM) - corresponding to 0.16 pc at W3's distance.

Data analysis is in the early stages, however considerable clump and filamentary structure is present in the vicinity of the IRAS-traced star formation regions located along the NE edge of the cloud, adjacent to the W4 HII region. The SF within this region is believed to have been triggered by the expansion of the HII region (Lada 1978). Figure 1 shows the mapped region overlaid with CO J=1-0 emission line contours from the FCRAO Outer Galaxy Survey (Heyer et al. 1998, ApJS, 115, 241) (Click here for full-size image). The contours represent the corrected antenna temperatures in the velocity range -57 to -32 km/s, contour levels are 12, 56, 100 and 144 K. Since the large scale structure in SCUBA scan-maps is unreliable it has been removed by convolving the original map with a Gaussian beam of FWHM 136" (twice the maximum chop throw), and then subtracting the convolved map from the original. The resulting map was then convolved with a Gaussian point spread function (14" FWHM). There is a good correspondence between the highest contours of CO emission and the brightest continuum emission. Figure 2 (click here for full-size image) presents the SCUBA map with the positions of the main SF regions indicated. The blue crosses represent the positions of the nine 0-type stars which comprise OCl352, the star cluster which is ionizing the W4 HII region (Normandeau et al. 1996, Nature, 380, 687-689).



Within the region surveyed we have identified some 250 objects, using the Williams clump-finding algorithm (CLFIND2D - Williams et al. 1994, ApJ, 428, 693). We have determined the clump positions and sizes and are in the process of estimating clump masses using temperature determinations from IRAS HIRES data. Ongoing work includes:-

- Determination of the local clump-mass spectrum - these results will be compared to theoretical predictions of the mass-fragment spectrum in collapsing compressed shells.
- Evaluation of clump number density as a function of cloud position. This will reveal the extent to which clump structure is formed preferentially close to known SF sites as part of the process of induced SF.
- Combination of the W3 SCUBA data with our unbiased CO J=1-0 survey of W3 (taken at FCRAO 14m with beam-width, 44" at 115 GHZ, sampling) and HI data from the Canadian Galactic Plane Survey. This will enable us to study the cloud kinematics, e.g. the bulk gas motions within the cloud and whether the cores detected at 850 microns exhibit high velocity gas (typically associated with molecular outflows).

The analysis of the W3 dust continuum emission, coupled with cloud kinematical data (CO and HI) will provide a powerful set of constraints which models of SF will need to reproduce.

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back to:> Newsletter Index

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D.E. Bretherton - ARI, Liverpool John Moores University

Back to: The JCMT Newsletter Index

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.

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.

Back to: The JCMT Newsletter Index

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Gerald Moriarty-Schieven

Back to: The JCMT Newsletter Index

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Back to: The JCMT Newsletter Index

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Gerald Moriarty-Schieven (gms)

Back to: The JCMT Newsletter Index

NEXT ISSUE DEADLINE

The deadline for submission of science and/or technical articles for the next issue of this Newsletter is **25 February 2003**. *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**).

Back to: The JCMT Newsletter Index

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