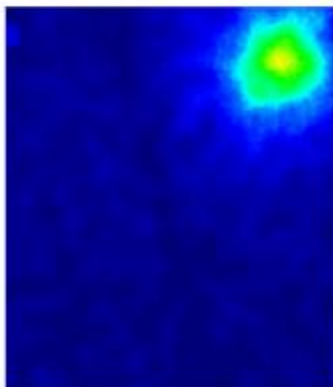


This newsletter was originally published in electronic form by the Joint Astronomy Centre on their web site. This PDF version was created using the web pages still available in August 2014. The most important pages are preserved. The missing pages tend to be administrative in nature and are unlikely to have historical value.

# The JCMT Newsletter



Measuring the Sunyaev-Zel'dovich  
Effect with SCUBA

## September 2003 Issue Number 21

### **GENERAL ANNOUNCEMENTS**

[From the Director's Desk](#)

[Call for Proposals for Semester 04A](#)

[The Nightwatchman](#)

[RCUH Employees of the Year](#)

[JCMT adopts AIPS++ for spectral line data reduction](#)

[Public Outreach Update](#)

[Astronomical Polarimetry Conference, March 2004](#)

### **PATT INFORMATION**

[PATT Application Deadline](#)

### **INSTRUMENTATION/FACILITIES UPDATE**

[Heterodyne Instrumentation](#)

[SCUBA and SCUBA Polarimeter](#)

[FTS](#)

[SPIFI](#)

[MPI 800GHz Receiver](#)

[The 186GHz Water Vapour Monitor](#)

[Tau, Seeing & Sensitivities](#)

[First Light with ROVER](#)

[SCUBA-2 Update](#)

[Observation Management Project Fully Implemented](#)

[Electronic Submissions](#)

[Flexible Scheduling Guidelines](#)

[JCMT Allocations for Current/Previous Semesters](#)

[JCMT Working Schedule](#)

### ***STATISTICS***

[Weather Stats for Semester 03A](#)

[Weather Stats for Semester 02B](#)

[Operational Statistics for 2002](#)

### ***ABOUT THE NEWSLETTER***

[Points of Contact](#)

[Next Submission Deadline](#)

### ***SCIENCE HIGHLIGHTS***

[ISM Properties in Low-Metallicity Environments](#)

[The Brightest GRB Afterglow](#)

[Submm Detection of Brown Dwarfs](#)

[Measuring the Sunyaev-Zel'dovich Effect](#)

[Winds in the Mesosphere of Venus](#)

[SCUBA Image of L1551 Starburst Region](#)

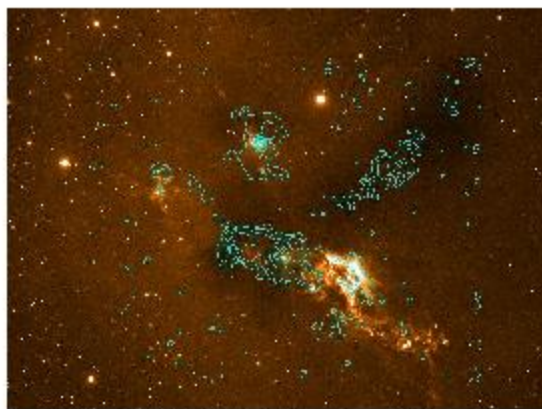
[JCMT Citations 1990-2001](#)

[JCMT Publications](#)

[JAC Internal Science Seminars](#)



*The  
JCMT  
Newsletter*



**The L1551 Molecular Cloud**

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[back to:> The JCMT Home Page](#)

Click [here](#) for printable version.

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[Gerald Moriarty Schieven](#)

# From the Director's Desk



In my previous [column](#) in this newsletter, I alluded to a reorganisation of the JCMT Group at the JAC, which was at that time in the works. This change has since been approved and fully implemented. The post of Associate Director, formerly held by Dr Per Friberg, has been replaced by two new positions: a Head of JCMT Instrumentation and a Head of JCMT Operations. The former post has been taken by Per, while Dr Remo Tilanus has been appointed to the latter. Both Per and Remo have taken up their new duties with energy and enthusiasm, and we are already reaping the benefits of this.

The major development at the telescope since my last column is the continued, incremental implementation of the [Observation Management Project](#) (OMP). The Observing Tool released for semester 03B, which has just started as I write this, allows PIs to enter both heterodyne and SCUBA programmes into the database for the first time. Together with the queue management tools and PI feedback tools, the OMP software suite is now virtually complete. Our next target in this development is a thorough revision and reorganisation of the JCMT web pages to fully integrate the new observing paradigm. I remain convinced that the shift to flexible scheduling, which drove the development of the OMP, will enhance the scientific productivity of the JCMT.

At the time of writing, the facility and instruments are performing well. The secondary mirror unit was removed from the telescope in July for its first complete overhaul in many years: the mechanisms were stripped, cleaned, lubricated and reassembled. In the course of this work we discovered some failure modes waiting to happen, so the downtime was well worth it. The heterodyne receivers are all functioning well, with the exception of RxW, in which one C-band mixer recently failed; the device is currently at MRAO for assessment. SCUBA has continued to perform reliably since the cryogenic repair last November, but it continues to exhibit erratic noise levels, for reasons which we have so far been unable to identify.

The next new instrument to arrive at the JCMT will be [THUMPER](#), a 200 $\mu$ m imaging photometer being developed at Cardiff (PI: Dr Derek Ward-Thompson). A four-week period of daytime integration work is scheduled to begin on 3 November. THUMPER has been awarded 9 shifts during the remainder of semester 03B for astronomical commissioning, which will be flexibly scheduled to take advantage of the best weather as it occurs. Assuming all goes well, THUMPER will then be available to the entire JCMT community as a common-user instrument beginning in semester 04A.

Looking ahead, 2004 will be an extremely busy year at the JCMT. ACSIS, the new correlator which will replace the venerable DAS, is currently scheduled to arrive in March. Infrastructure work is already in progress to make room for the four racks of ACSIS electronics on the carousel floor. [HARP-B](#), the imaging heterodyne receiver which will replace the current workhorse instrument RxB, will arrive not long afterwards. The commissioning of these two instruments will keep our engineering, software and scientific staff extremely busy. Finally, a new polarimeter called [ROVER](#), being developed for use with HARP-B and RxA, has already been used successfully at IRAM and will be ready for commissioning at the JCMT during 2004.

The flagship development for the JCMT is, of course, [SCUBA-2](#). I am pleased to be able to report that the project is making excellent technical progress, and is on schedule for delivery in late 2005. Unfortunately, we

have not yet identified sufficient funds to enable us to build the instrument to specification: the funds received to date from the UK Office of Science and Technology, the Canada Foundation for Innovation and the JCMT Development Fund make up about 85% of the total cost. While a descope plan is in place should it be needed, I am busily seeking the additional funds which will enable the full instrument to be built. This is a critical element of the strategic plan for the JCMT.

Our current long-range plan calls for the following instrument suite on the JCMT from 2006 onwards: HARP-B, with ROVER as its polarimeter; SCUBA-2; and two ancillary instruments for SCUBA-2, a Fourier transform spectrometer and a polarimeter, which are being developed in Canada. Because these instruments lend themselves to large-scale survey-style observations (particularly SCUBA-2), it is appropriate at this time to begin the development of a survey strategy. In order that this strategy may be driven by the user community, the JCMT Board has designated three individuals to lead this debate within their countries: Rob Ivison (UK), Gilles Joncas (Canada) and Paul van der Werf (Netherlands). The development of a robust and scientifically strong survey strategy which will take maximum advantage of the JCMT's future capabilities is critical for the future of the facility, and I encourage any users with an interest in this development to contact one of the individuals listed above.

Although the Board approved the development of linked interferometry with the SMA in 1996, little has happened since then while we have waited for the SMA to be ready. In view of the time which has now passed since the Board's decision and the developments elsewhere in submm interferometry (e.g., CARMA), I have convened an ad hoc panel from amongst the community to review the scientific case for this project. The JAC will, in parallel, review the technical plan and the cost of the project. The future of this project will, on the basis of these assessments, be reconsidered by the Board at its next meeting in November.

The end of June marked the end of an era at the JCMT, when we said farewell to Henry Matthews, who was recalled to Canada by the HIA. Henry had been with the JCMT for 15 years, and his vast experience with the observatory will be missed. I wish him every success in his new position at DRAO. Henry has been replaced by Ming Zhu, a former PhD student and Research Associate of Ernie Seaquist. Ming and Gerald Moriarty Schieven will continue to provide support for Canadian users of the JCMT. In other personnel matters, Greg Sarge, our newest Telescope System Specialist, joined us in early July.

Professor Gary Davis  
Director JCMT  
4 August 2003

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back to:> [Newsletter Index](#)

Click [here](#) for printable version.

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[Gary Davis - Director JCMT](#)

The Nightwatchman

Edition 6

Autumn 2003

Hilo, September 1

TSS Support

JCMT welcomes a new TSS this summer as Greg Sarge has joined the JAC. Greg becomes the fifth JCMT TSS and will be training at the summit during the summer and autumn as he familiarizes himself with the JCMT systems.

The OMP and WOLF

The OMP group had continued to supplement and improve its software suite at JCMT. Most recently released by the group is the WOLF software that will allow investigators to eavesdrop more efficiently on data collected for their projects.

First, investigators will notice that observation logs in the OMP system now include links under a "WOLF" column that allow quick-looks at images produced from a preliminary reduction of the data. This functionality exists both for SCUBA and for DAS data collected using the more common observing setups at JCMT.

Second, investigators will notice that their main project feedback page now includes a link entitled "Click here to remote eavesdrop". Since most data is not available until it is formally packaged after the entire observing night finishes, this link will allow investigators to eavesdrop on the current observing night's data if any has been taken for their project. In addition to in-progress observational logs, WOLF preliminary reduction images are available.

Support for non-standard or infrequently-used data acquisition modes may be added in the future.

The Nightwatchman's Broadside

I have developed The Nightwatchman's Broadside: an Observer's Guide to JCMT Summit Computing. This new document is effectively an FAQ for observers with a focus on observing computing issues.

An oversize, laminated, full-color version hangs in the JCMT control room, although observers can download a copy in PDF format for themselves directly from The Nightwatchman website.

La Citation du Semestre

Astronomers say the universe is finite, which is a comforting thought for those people who can't remember where they leave things.

Woody Allen

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

Jonathan Kemp

[www.jach.hawaii.edu/~jkemp](http://www.jach.hawaii.edu/~jkemp)

[j.kemp@jach.hawaii.edu](mailto:j.kemp@jach.hawaii.edu)

# RCUH Outstanding Employee of the Year Award

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*RCUH employees of the year 2002.*

You may not know this, but JAC employees are not actually employees of the JAC at all — they are all employed by various management organizations. The Research Corporation of the University of Hawaii (RCUH) employs the vast majority of us, but a few are still employed by the partner agencies (PPARC, NWO and NRC). RCUH is attached to the University of Hawaii for administrative purposes, but is largely an independent, self-supporting entity whose mission is to enhance research, development, and training generally in Hawaii. It is now a large organization with over 1800 employees employed in all manner of research projects throughout Hawaii. Every year RCUH invites nominations for the Outstanding Employee of the Year award and a panel of 5 judges selects which employee has made the most demonstrable, significant, and outstanding performance, contribution, or achievement to his/her project. JAC is proud of its record in this award, having had two previous winners in the past 15 years.

This year the award went jointly to Frossie Economou and Tim Jenness from the JAC. Tim and Frossie were project manager and chief technical lead of the JAC [Observation Management Project](#) - a project that has been responsible for automating nearly all of the key processes at the heart of the JAC production of Science Data. This was been released on both the JCMT and UKIRT and their independent communities during Semester 2002B.

Since few people fully appreciate the significance of these changes (it is "only software", after all), very few realized (or realize) the difficulty of what they have had to do. In changing our business processes they have had to interact with our entire user community (four countries) plus our local operations (two telescopes, with very different corporate cultures up to now), and keep all these interested parties happy, whilst also changing, fundamentally, the way we work. The only way they managed to complete the project successfully was through their tremendous knowledge, understanding, dedication and drive. Since they were trying to change the way people work, they naturally met resistance, and Frossie spent a large amount of time just seeking out people who were willing to contribute and support the project in some key areas. Without this input from a cross section of users the project could not meet its goals.

Tim had to cope with a conflicting set of user requirements from the two different communities and has had to merge them into a single coherent design. They then had to distill this design into sub-systems individual software engineers could produce, and motivate their team into delivering a great product on time and on budget. The release of the software spanned a four-month period from July to October 2002 and both Frossie and Tim worked 14 hours a day, 7 days a week during the commissioning period. Frossie worked from 8am to 10pm and was present on the mountain to give the personal support. Tim worked from 2pm to 4am and worked in Hilo using the video conferencing system. The whole process was extended by the run of poor weather we had in early 2002B, and so the support had to be continued way beyond the two weeks initially scheduled until the systems were fully tested. All of this was, of course, extremely draining, and would have taken its toll on lesser individuals. However, throughout the period both Tim and Frossie maintained a positive attitude, dealing personally and calmly with all the new observers' fears and questions, and continuously improving the system as time went on.

Needless to say, the OMP has been an enormous success and Tim and Frossie's efforts were recognized at the RCUH Outstanding Employee of the Year award ceremonies in February. I am sure I echo everyone's sentiments in wishing them a hearty congratulations on a job well done!

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back to:> [September 2003 Newsletter Index](#)

Click [here](#) for printable version.

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[\*Nick Rees\*](#)

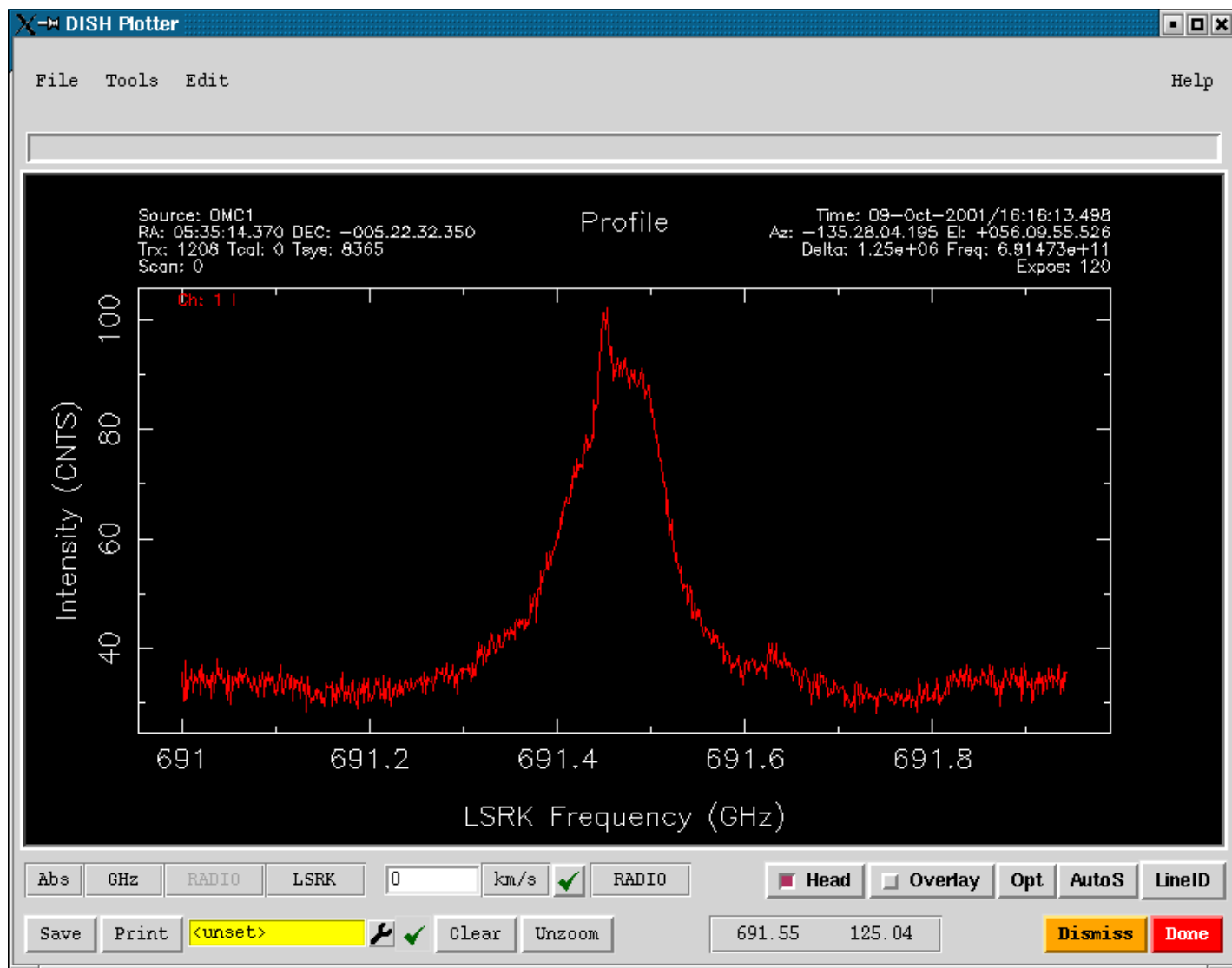


## JCMT adopts AIPS++ for spectral line data reduction

The JCMT is preparing to adopt AIPS++ for spectral line data reduction. The software is well suited to handling data from existing JCMT receivers and will enable sophisticated handling of spectral line data cubes from HARP/ACSIS. As a consequence, it is expected that support for SPECX by JCMT staff will eventually be discontinued. AIPS++ is available for Linux (on Intel based machines) and Solaris (on SPARC-based workstations). AIPS++ features include:

- A fully featured scripting language called glish. This features a C-like syntax together with powerful capabilities for manipulating data in arrays and tables (similar to IDL). Glish will enable greater automation of data reduction tasks than is currently possible using SPECX macros.
- A single-dish specific data reduction and visualisation tool known as DISH. This enables tasks such as co-adding spectra and baseline fitting to be performed either via a GUI or via the glish command line.
- Advanced image handling capabilities via the image tool. The image tool incorporates features such as visualisation, mask handling, source profile fitting and statistical analysis.
- Tk and PGPLOT bindings for glish, allowing the user to build custom GUIs and rapidly produce publication quality graphics from data. AIPS++ thus possesses the flexibility to be successfully used for a wide variety astronomical visualisation and analysis.

AIPS++ lies at the heart of the data reduction system for ACSIS. The generation of spectra from the raw autocorrelation lags is achieved by the use of parallel, distributed reduction tasks (written in C++) co-ordinated by the glish scripting and messaging system. It is envisaged that the raw spectra will be saved to disk as AIPS++ measurement sets, while gridder tasks will produce FITS format data cube slices. It is anticipated that JCMT users will then use AIPS++ for further analysis and reduction of their data from the ACSIS backend.



**The DISH Plotter window.**

The native AIPS++ data format describing observations is the Measurement Set (MS). At present, such measurement sets can be constructed from existing GSD format data files from the JCMT using a GSDfiller program. Glish equivalents of the SPECX dasmerge function have been developed, enabling the straightforward reduction and visualisation of JCMT data from the current DAS backend.

The training of support scientists in the reduction of JCMT data with AIPS++/DISH will begin in the autumn of 2003. Regular users of JCMT spectral line instruments will then be encouraged to try AIPS++ and DISH for themselves, ahead of the commissioning of ACSIS on the JCMT. Data from ACSIS will be reduced using AIPS++, in conjunction with the provision of an ORAC-DR data reduction pipeline for quick-look data reduction and visualisation at the summit.

Further information can be found at:

- [The AIPS++ homepage](#)
- [The ACSIS homepage](#)
- [The HARP homepage](#)

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Back to: [The JCMT Newsletter Index](#)

Click [here](#) for printable version.

# JCMT public outreach activities

**Douglas Pierce-Price** - *Joint Astronomy Centre*

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Since the last newsletter, the JCMT has featured in various JAC public outreach events. These included public talks in Hilo and at the Onizuka Visitor Information Station on Mauna Kea, and the JAC display at [AstroDay 2003](#). [Photographs from this event](#) are available on our [public outreach website](#).

Some recent JCMT-related press releases and activities:

- The SCUBA high-redshift quasar observations by Ian Robson, Robert Priddey, Kate Isaak, and Richard McMahon were featured in New Scientist following presentation at the UK National Astronomy Meeting 2003.
- A press release accompanied the publication in Nature of "Type II supernovae as a significant source of interstellar dust" by Loretta Dunne, Stephen Eales, Rob Ivison, Haley Morgan, and Mike Edmunds. This was well covered, with reports on the [New Scientist](#) and [Scientific American](#) websites, in the [Christian Science Monitor](#) (which also covered SCUBA high-redshift quasars and a [related UKIRT result](#)), the [Guardian](#), and elsewhere. You can read the [original press release](#) on the [outreach site](#).
- JCMT was also filmed for a German television programme, "Abenteuer Ferne",
- and was featured in an astronomy supplement published by the Hawaii Tribune-Herald.

If you have some interesting JCMT (or UKIRT) work and would like to arrange a press release about it, please get in touch with me at ["outreach@jach.hawaii.edu"](mailto:outreach@jach.hawaii.edu).

For more information on our outreach activities, please see our [public outreach site](#).

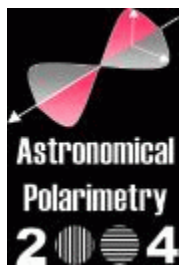
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back to:> [September 2003 Newsletter Index](#)

Click [here](#) for printable version.

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[Douglas Pierce-Price](#)



# ASTRONOMICAL POLARIMETRY CURRENT STATUS AND FUTURE DIRECTIONS

15-19 March 2004

**Waikoloa Beach Marriott, Waikoloa, Hawaii**

## Second Announcement

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Dear Colleague,

We are pleased to confirm the holding of a Workshop on optical - infrared - mm/submm (OIM) Astronomical Polarimetry, in the wonderful surroundings of the north Kona coast in March 2004. The aim of the Workshop is to bring together workers in all areas of OIM astronomical polarimetry to discuss the most recent results in this exciting and crucial field, and to consider the potential for polarimetry in the era of eight- and ten-metre optical and infrared telescopes. The meeting will concentrate on ground-based polarization measurements, and will include a session devoted to new and novel instrumentation. The remaining sessions will be organized according to the astronomical source rather than to wavelength regime or specific technique. Neither Radio polarimetry nor Solar polarimetry are within the conference remit, but each will be the subject of review talks which will set the scene for two of the conference sessions.

The [conference web site](http://www.jach.hawaii.edu/JACpublic/JAC/pol2004), including conference registration forms, is open at <http://www.jach.hawaii.edu/JACpublic/JAC/pol2004>. If you wish to be put on the conference email list, please send a message to [pol2004@jach.hawaii.edu](mailto:pol2004@jach.hawaii.edu)

## SCIENCE AREAS

Sessions will be divided into two, with approximately 80% of the time guaranteed for current results and 20% for presentations on future directions, facilities etc. Proceedings, including posters, will be published. Details of the division between oral and poster presentations will be given once the relative demands are known. The web site gives details of expected sessions, each of which will consist of an invited review and a number of contributed talks.

The following science areas will be covered:

- Techniques and Instrumentation, Data Analysis
- Theory and Modelling
- Star Formation
- Extrasolar Circumstellar matter

- Ejecta
- Interstellar Dust and Gas
- Stars, CVs, Magnetic Stars
- Galaxies, Radio Galaxies and AGN
- High-redshift and Cosmological Polarimetry

Invited reviewers:

- Dave Aitken
- Tim Cawthorne
- Clive Tadhunter
- Tim Gledhill
- Alyssa Goodman [TBD]
- Jane Greaves
- Jim Hough
- Alex Lazarian [TBD]
- Haosheng Lin
- Nadine Manset
- Brenda Matthews
- Francois Menard
- Angelica de Oliveira-Costa
- Motohide Tamura

## **DATES AND DEADLINES**

- End of Early Registration: 1-Dec-2003
- Abstract Deadline: 1-Jan-2004
- Late Registration Deadline: 1-Feb-2004

## **SPONSORING ORGANIZATIONS**

- Joint Astronomy Centre
- Subaru Telescope
- Canada-France Hawaii Telescope
- Gemini Observatory
- University of Hawaii Institute for Astronomy
- W.M.Keck Observatory
- Caltech Submillimetre Observatory

## **SCIENCE ORGANIZING COMMITTEE**

- Andy Adamson - Joint Astronomy Centre
- Pierre Bastien - Université de Montréal
- Chris Packham - University of Florida
- Colin Aspin - Gemini Observatory
- Ian Robson - UK Astronomy Technology Centre

- Martin Houde - Caltech Submillimeter Observatory
- Jim Hough - University of Hertfordshire
- Jeff Kuhn - University of Hawaii
- Nadine Manset - Canada France Hawaii Telescope
- Motohide Tamura - National Astronomical Observatory of Japan
- Bob Goodrich - W. M. Keck Observatory

#### LOCAL ORGANIZING COMMITTEE

- Andy Adamson - Joint Astronomy Centre
- Chris Davis - Joint Astronomy Centre
- Colin Aspin - Gemini Observatory
- Douglas Pierce-Price - Joint Astronomy Centre
- Dolores Walther - Gemini Observatory
- Gerald Moriarty Schieven - Joint Astronomy Centre
- Sally Nicol - Joint Astronomy Centre
- Takuya Fujiyoshi - Subaru Telescope
- Donna Delorm - Joint Astronomy Centre

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Contact email address: [pol2004@jach.hawaii.edu](mailto:pol2004@jach.hawaii.edu)

Web site: <http://www.jach.hawaii.edu/JACpublic/JAC/pol2004>

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back to:> [September 2003 Newsletter Index](#)

Click [here](#) for printable version.

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[\*Pol2004 LOC\*](#)

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Back to: [The JCMT Newsletter Index](#)

## PATT Application Deadline

Deadlines for receipt of all JCMT applications for semester 04A is:

15 September 2003

Please read the article - [Applying for Time](#) before filling in your application forms for the forthcoming 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

<a href="#">Canada</a>	<a href="#">Netherlands</a>	<a href="#">UK or International</a>
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Back to: [The JCMT Newsletter Index](#)

Click [here](#) for printable version.

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

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Back to: [The JCMT Newsletter Index](#)

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## Weather Statistics for Semester 03A

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The following tables present the weather loss for semester 03A. For losses due to faults see the [Operational Stats](#). With (practically) fully flexible queued observing now in operation, no distinction is made any longer between "Primary" and "Backup" projects. These statistics are generated by the [OMP](#) (Observation Management Project) reporting system.

The lost time due to weather over 03A has been extraordinarily small, especially in comparison to the previous two semesters. One item to note, the reduced time in July was due to a two week, unanticipated shutdown, during which the secondary mirror unit was removed and extensively overhauled. (See the [Director's Report](#) for details.

Month	Available	Extended	Lost to weather	%
Feb	446.8	13.5	24.5	5.5
Mar	496.0	12.1	69.6	14.0
Apr	432.0	10.8	79.6	18.4
May	494.5	16.9	35.1	7.1
Jun	479.8	26.9	48.1	10.0
Jul	277.8	6.6	2.7	1.0
Totals	2627	86.7	259.4	9.8

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[Iain Coulson](#)

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back to:> [Newsletter Index](#)

Click [here](#) for printable version.



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Back to: [The JCMT Newsletter Index](#)

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## Weather Statistics for Semester 02B

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The following tables present the weather loss for semester 02B. 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	408.0	17.4	272.2	66.7	192.9	47.3
Sep	431.0	6.7	236.9	55.0	86.4	20.1
Oct	503.0	13.1	226.7	45.1	138.5	27.5
Nov	463.8	16.9	147.6	31.8	22.1	4.8
Dec	440.0	30.4	69.8	15.9	22.9	5.2
Jan	367.9	12.7	104.2	28.3	39.8	10.8
Totals	2613.7	97.2	1057.4	40.5	502.6	19.2

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[Iain Coulson](#)

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back to:> [Newsletter Index](#)

Click [here](#) for printable version.

# SPIFI: The South Pole Imaging Fabry-Perot Interferometer

SPIFI, the South Pole Imaging Fabry-Perot Interferometer, will not be available for use at the JCMT during semester 04A. For further information consult [Cornell Astronomy Department Site](#).

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back to:> [Newsletter Index](#)

Click [here](#) for printable version.

*[Gerald Moriarty Schieven](#)*

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**Back to:** [The JCMT Newsletter Index](#)

## **Max-Planck-Institut 800 GHz Instrument**

The MPIfR/SRON heterodyne receiver (MPIRE) has been "retired", and will not be returning to the JCMT.

Further details can be found at:

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

**Back to:** [The JCMT Newsletter Index](#)

Click [here](#) for printable version.

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

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# The JCMT 183GHz WVM

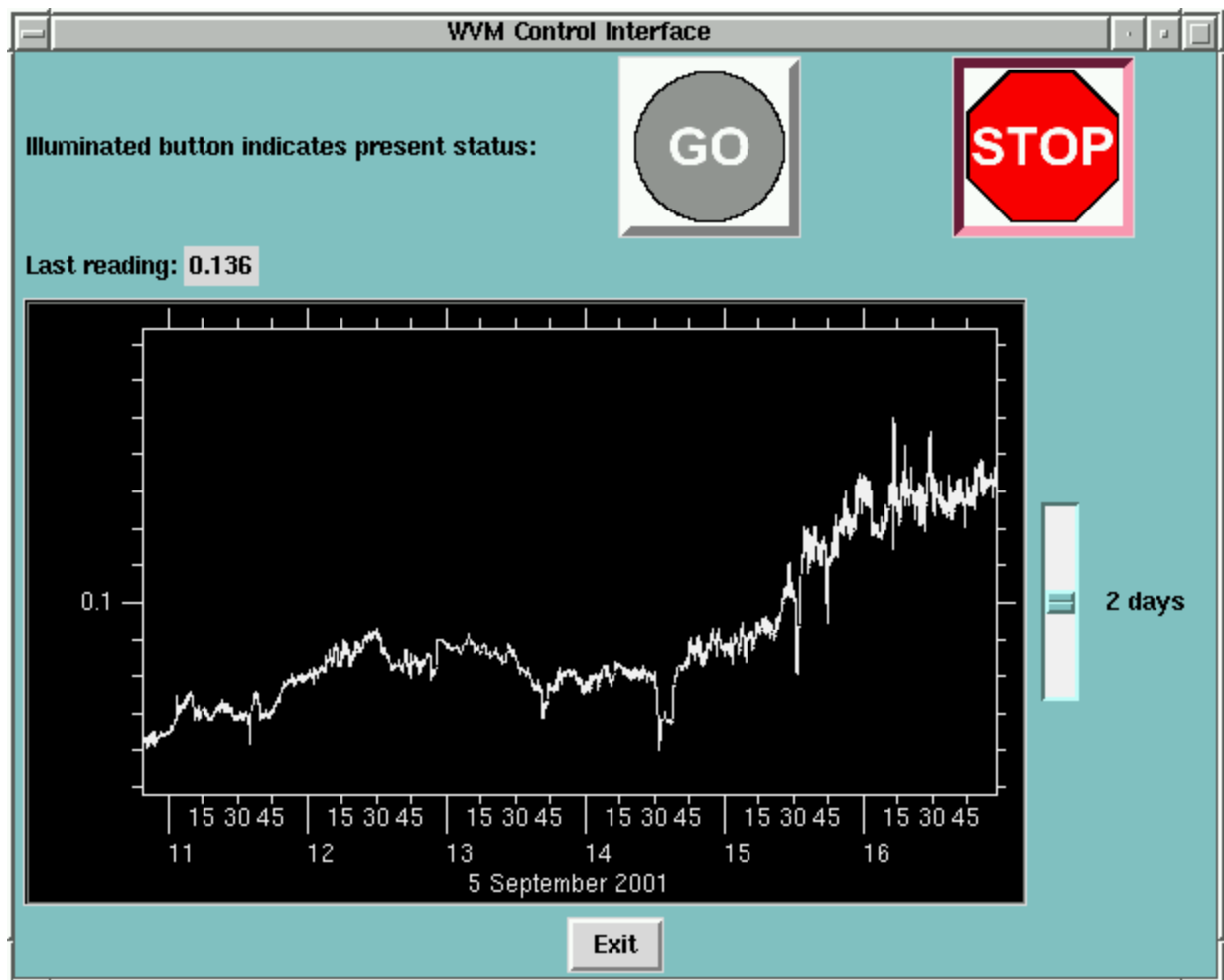


Since the summer of 2001 the JCMT has been regularly using a cabin mounted Water Vapour Monitor (WVM) provided to the JCMT by MRAO. Built as a thesis project by Martina Wiedner (under the supervision of Richard Hills) it works by looking at the 183GHz water vapour line using a three channel double side 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.

There is now a web-based interface which will allow you to download WVM data or display the same data in graphical form, for any date for which data are available. This interface is available [here](#).



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back to:> [Newsletter Index](#)

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[Bernd Weferling](#)

# 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](#).

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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  $\tau_{\text{cso}} = 0.3$  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.

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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. In addition, [WVM](#) data can also be downloaded from the web [here](#).

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back to:> [Newsletter Index](#)

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[Gerald Moriarty-Schieven](#)

# FIRST LIGHT WITH ROVER

J.S. Greaves - ROE/ATC

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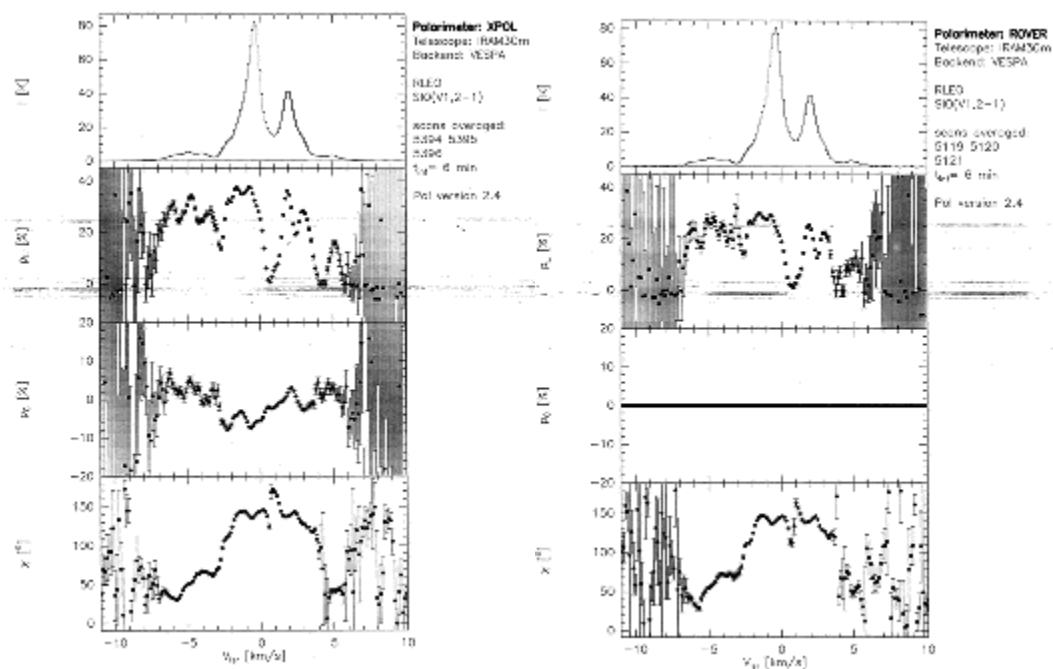
*Inside the ROVER module. The large blue circle is the waveplate (blue because it's made of sapphire!). The dark and light segments are the encoder, which triggers the TTL pulse that is used for logging the waveplate cycles.*

The ROVER spectral-line polarimeter has just seen first light, although not yet at JCMT. It 'roved' to the IRAM 30m telescope in Spain in May 2003, under the care of Jane Greaves and Sye Murray - whom those of long memories may recall from the commissioning of the UKT14 and SCUBA polarimeters. We observed at 3mm wavelength, in a variety of conditions ranging from fog to snow to glorious sunshine (it was daytime!). Some of the first results are shown below.

The main aim of this observing run was to prove, once and for all, that millimetre spectra-line polarimetry gives real science results and is not contaminated by instrumental polarization effects. This has been a long-standing criticism since the early 1980's when the first attempts were made to measure weakly polarized lines from molecular clouds. JCMT results published over the last few years have been very impressive, but there are a number of subtle effects like sidelobe polarization that are hard to quantify. So, we took advantage of a unique opportunity to compare the polarization measured with a waveplate device (ROVER) with the same polarized source seen with a 'correlation polarimeter'. IRAM have been developing observations in this mode, using a pair of receivers accepting the two orthogonal planes of light and extracting the correlated (polarized) component. Our idea was that if the two polarimeters produce the same signal, by completely different methods, then it must be 'real'. There is probably no other telescope where this could be tried, and we pushed the system to the limits, including sampling the spectra at an impressive rate of 32 Hz!

Figures 1 and 2 show the results we obtained for the SiO Maser in the envelope of the star R Leo. Can you tell which is taken with which instrument?? (They are so close, at first we thought we'd analysed the same data twice by mistake!). The sharp-of-eye may notice that there is a flat line in the ROVER data - this is circular polarization which we can't measure with a half-wave plate. Also, the percentage of linear polarization is slightly less than with the IRAM 'Xpol' results, because the data are not yet corrected for the polarizing efficiency of the plate. Apart from that, the shape of the percentage and angle of polarization curves is exactly the same - just the proof that has been sought for so long.





Figures 1 & 2 - ROVER and Xpol spectra of R Leo in the SiO  $v_1, J=1-0$  line. From top to bottom: total intensity, percentage of linear polarization, percentage of circular polarization, direction of linear polarization.

We obtained a few other science results - most importantly, detecting polarized CO from Mira giant stars, which has never been done before - and also did some work on optimising observing modes. It turned out the simplest mode was the best: we simply took data as fast as the correlator could sample, while simultaneously spinning the waveplate. Each sample then corresponds to a small range of plate angles, and can be analysed as though it is all one fixed angle (which is what we get with SCUBA polarimeter data, for example). To analyse the data, all you have to do is compare the time stamps of the spectra and the polarimeter cycles - all done by logging and with a single TTL pulse. This continuous spinning observing mode (another 'first') was very efficient and is the way we plan to observe also at JCMT.

The instrument performed beautifully and the only real problem we had was fitting it in the receiver cabin! I would very much like to thank the ATC team who built the polarimeter (especially Ian Laidlaw and Brenda Graham), all the IRAM staff who helped us, and the Directors who allowed us to take the risk of removing one of the delicate beam-splitters so we could slide the polarimeter module in instead. Our IRAM colleagues Clemens Thum and Helmut Wiesemeyer also did heroic work with getting everything set up and having reduction software all ready so that we saw the polarization results immediately they came in. We are all now very pleased with the data (and also all very fit after running up to the cabin to check the polarimeter rotation - it's a long way to go, halfway up a 30m!).

The final stages of the ROVER project are to design and test the JCMT waveplate - hopefully this will be achromatic covering both the A and B bands, so there will be no need to swap plates. ROVER should be coming out in spring 2004 to be included in the late stages of ACSIS commissioning, and will be available to the community as soon as possible thereafter. And when HARP-B comes online, ROVER will also provide the world's only imaging spectral polarimeter for the submillimetre regime. The scientific advances we can then make should be as dramatic as those made with the SCUBA polarimeter.



# An update on SCUBA-2

Wayne Holland - UKATC/ROE

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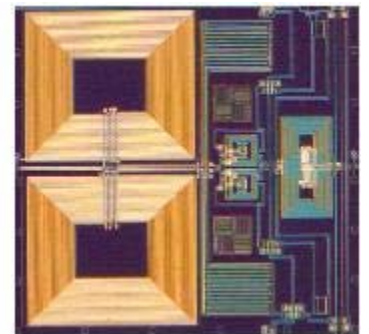
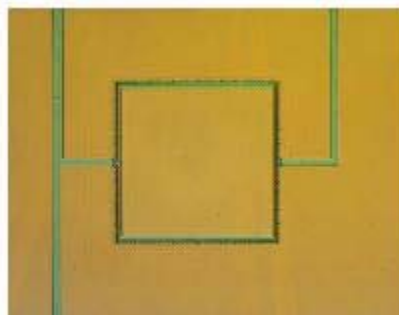
SCUBA-2 has continued to make good progress over the past year. The highlights have been an extremely successful Proof-of-Concept review for the array technology and a preliminary design review for the main instrument (more details are given below).

On the funding side, the majority of the money needed is now in place following the announcement of the Canadian CFI contribution and approval by PPARC Council. However, following a major re-costing exercise it has become clear that the project is still £1.5m short of the funds needed to complete the instrument (which includes a contingency). Efforts are underway, led by the Director JCMT, to bring extra money into the project before April 2004. Should the shortfall not be realised then the project will be faced with a major de-scope of having only one sub-array at each wavelength - one-quarter of the original focal plane or a loss of a factor of 4 in survey (mapping) speed. Everyone on the project sincerely hopes that this will not be necessary as it represents a huge loss in performance.

## 1. Array development

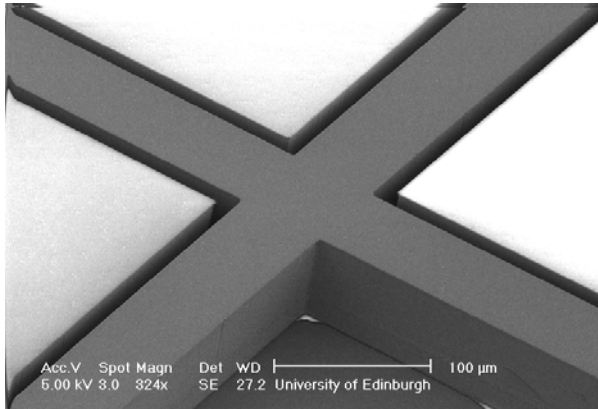
In November 2002, a highly successful Proof-of-Concept review was held for the technologies that would be needed to construct a SCUBA-2 sub-array. These included the transition edge pixels themselves, unit cell multiplexers, silicon deep etching, thermal interfaces and bump bonding. Out of the 18 identified technologies, 16 were shown to be under control, with the only uncertainties over the bump bonding - used to hybridise the detector and multiplexer chip, and the deep etching - used to form the pixel and array structure. In particular, optimised single pixels and multiplexers were shown to be capable of meeting the SCUBA-2 requirements in terms of sensitivity, speed of response, power handling and thermal conductance. Figure 1 shows a close-up of a TES pixel and the complex multiplexer unit cell design.

**Figure 1:** (left) Photograph of a TES test pixel. On the right are the heater leads used to control the operating point, whilst the actual TES leads are on the left. The pixel dimensions (central square) are 1.135mm on a side. The patterning for the legs and slots can also be seen around the periphery of the pixel. (right) The physical layout of the SQUID multiplexer unit cell. The "large" input transformers are seen on the left as well as the summing coil gradiometers on the right. In the centre are the active and dummy SQUIDs (the latter of which is used to reduce crosstalk).



Since the P-o-C review, work has concentrated on understanding and improving the thermal aspects of the bump bond process and refining the deep etch process. New bump-bonded samples are about to undergo

thermal tests in Cardiff, following changes in the design that have increased the bump bond density. It is expected that these tests will conclusively demonstrate the required thermal performance. The progress on the deep etching has been spectacular. Figure 2 shows a recent SEM photograph of a section of the array structure.

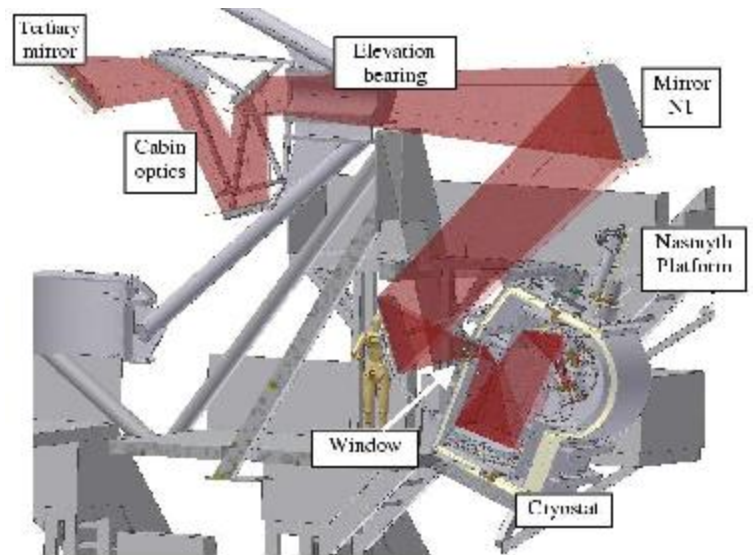


**Figure 2:** SEM photograph of a section of a SCUBA-2 sub-array. The white squares are the absorber "bricks" underneath which the TES pixels are deposited. The bricks are suspended on a silicon nitride membrane to control the thermal properties of the pixel. There is a 10 micron wide trench between the bricks and the 50 micron pixel wall (dark area). The deep etching has demonstrated control of the trench can be achieved to the tolerance required.

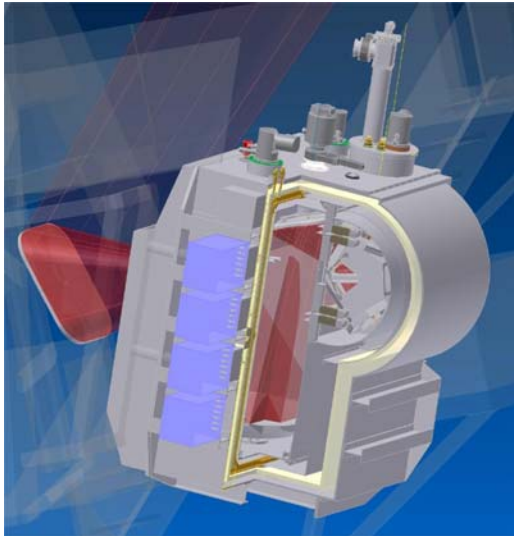
## 2. Instrument design

The SCUBA-2 instrument package is being developed in parallel with the array development. This includes the optics, cryostat design, electronics and software. The wide-field optical design has been frozen for some time and the contracts for the 8 re-imaging mirrors have been placed, with the first mirrors expected in March 2004. Figure 3 shows SCUBA-2 positioned at about the level of the current Mezzanine floor on the Left Hand 'A' frame. Considerable modifications will be needed to the platform (where SCUBA current resides) before SCUBA-2 can be installed.

**Figure 3:** View of the instrument on the telescope. The instrument mechanical design is driven by two principal requirements, the large field-of-view of  $8 \times 8$  arcminutes, and a detector operating temperature of 120mK. The large field-of-view results in extremely large mirrors (up to 1.4m across), the last 3 of which must be cooled to temperatures below 10K in order to reduce the thermal background on the arrays. This results in a very large cryostat, the vacuum vessel of which is 2.3m high, 1.7m wide and 2.1m long, with a pumped volume of  $5.3\text{m}^3$  – essentially a 'walk-in' cryostat!



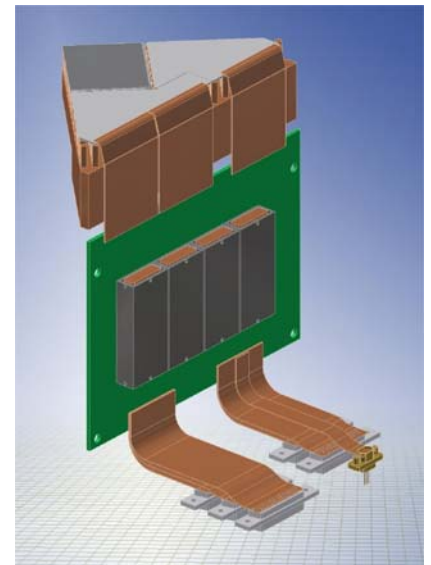
The cryostat underwent a preliminary design review in March this year and since then work has concentrated on detailing the design of the 1K box (which houses the arrays), the 4K optical bench (cold mirrors), radiation shields and vacuum vessel. Figure 4 shows a part cut-away section of the cryostat. As seen the cryostat is made up of a series of layers. Immediately inside the vacuum vessel is a multi-layer insulation blanket and 60K box that provides radiation shielding for the main optical bench, which is expected to operate at 4K. These are both cooled by a pair of pulse-tube coolers. The 1K box is cooled by the still of a dilution refrigerator. Mounted within the 1K box are the two Focal Plane Units that contain the cold electronics and the  $450\mu\text{m}$  and  $850\mu\text{m}$  arrays. A liquid cryogen-free dilution refrigerator cools the arrays to below 100mK.



**Figure 4:** Cut-away 3-D CAD drawing of the SCUBA-2 cryostat. The incoming beam envelope can be seen in red on the left-hand side. The beam is re-imaged by three cold mirrors - including one, which is over a metre in diameter and cooled to 4K! The 1K box sits inside the hemispherical section on the right. This box provides a light tight environment and also a magnetic shield for the sensitive SQUID multiplexers. The dilution refrigerator insert can be seen at the top of the cryostat.

The low-temperature thermal design and how the sub-array modules are cooled remains one of the most challenging aspects of the design. Each module is designed as an independent unit, which contains a sub-array of  $32 \times 40$  pixels. Figure 5 shows a drawing of an entire sub-array module.

**Figure 5:** A SCUBA-2 sub-array module. The gray square is the sub-array, attached via wire bonds, to a ceramic PCB that is in turn supported on copper "balcony" type structure. The niobium flexes are hot-bar soldered to PCBs at each end. The green PCB supports the SQUID series arrays at 1K, housed in shielded cans. Conventional ribbon cables bring the detector signals out of the cryostat to the warm, multi-channel electronics and data acquisition system.



The project will undergo a series of reviews over the next year or so. In summary, the following milestones have been identified:

- Multi-channel electronics PDR 22 Sept 2003
- Data reduction software PDR 24 Sept 2003
- Cryostat CDRs Nov/Dec 2003
- 1K box/cold shutter CDR end-Jan 2004
- Delivery of prototype sub-array to Cardiff Mar 2004
- Start of instrument integration Apr 2004

### 3. Science and surveys with SCUBA-2

Finally, discussions have begun about the form of future SCUBA-2 surveys. Some initial ideas were presented to the JCMT Board in June. It is clear that exciting and important scientific results can be expected from the unique surveys that will be facilitated by both SCUBA-2 and HARP. Like other survey projects (e.g. UKIDSS) consortia will have to justify the (presumably) large amounts of telescope time that would be needed for major surveys. The Board endorsed this approach and encouraged the community to discuss such surveys with a view to building the strongest possible science case(s), minimising duplication between the International partners, and planning for the availability of necessary resources. Rob Ivison (UK), Gilles Joncas (Canada) and Paul van der Werf (Netherlands) will liaise between the three partner communities and the JCMT Board. The JCMT Board meets again in late November and would welcome input from the community at that time, and/or at subsequent meetings.

Wayne Holland

SCUBA-2 Project Scientist (wsh@roe.ac.uk)

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back to:> [September 2003 Newsletter Index](#)

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# The OMP has been fully deployed!

**Frossie Economou** - *Joint Astronomy Centre*

Those of you who have been kindly looked upon by your TAGs in the last couple of semesters will have come across the many software changes introduced to JCMT and UKIRT as part of the JAC Observation Management Project (OMP for short). I am pleased to report that no software engineers were (permanently) harmed in the making of this software. In this article you'll find a cheat sheet to the more important project terminology, and the Unofficial And Only Slightly Expurgated History of the project.

## The OMP in a nutshell

Learn to use the [OMP](#) lingo! You will amaze your friends and confuse your enemies.

### The OT

Based on the old ORAC-OT, the OMP Observing Tool is a Phase II preparation tool that allows PIs to fully specify **MSBs** (Minimum Schedulable Blocks) for upload into the OMP database for observing. Although a single body of code, the OT is configured to come up in a different configuration depending on which telescope you want to use it for so as not to alarm people. These incarnations are referred to as the [JCMT-OT](#) and the [UKIRT-OT](#) for obvious reasons.

### The QT

The query tool is used at the summit to query the OMP database for MSBs that are suitable for the weather, the national queue, and a host of other allocation restrictions. Again, this is a single piece of software that runs up in UKIRT and JCMT incarnations.

### The Web Project [Feedback](#) system

This matrix of software tasks allows staff and PIs to access all information the OMP knows about, including the status of the project, access to the data, metadata about the observing conditions, logs, faults affecting the data and commentary by staff and observers about the the project. I hope I don't need to flog the "it's one piece of code for both telescopes" horse by now.

## Project Manager's Log

Here's the recap of what really happened. Well, the PG-13 version edited for the official newsletter anyway.

### 2001 January

The OMP, a previously conceived JCMT project is reborn as a JAC project and gets going with a new team. Unfortunately, we're stuck with the old name, which irritates me by having no word indicating that it is a software project, and by having no obvious mascot opportunities. I will continue to wistfully wish (read: whine) for a cooler name for the next 3 years and probably beyond.

### Time passes

We have a design, we have a review, we tweak the design some more, we have a mountain of dead whiteboard markers, we change our minds a few million times, we drag in anybody willing to help, we



have large head-shaped dents on the walls. Then there was Infrastructure, and we saw it was Good.

## 2002 June

Some of the systems are starting to come together. Given the upcoming marriage of the new OMP software system to the old JCMT instruments, the control room gets a dowry of shiny new kit, including top-of-the-line Linux PCs, flat panel monitors (much easier to carry up the stairs than the old 21-inch beasts), a Polycom unit for telecon over IP, a new colour fax/coper and a thorough dusting. Luckily the JCMT is closed due to heavy engineering, so we have plenty of time to set everything up.

## 2002 July

The first and largest OMP release containing the SCUBA JCMT-OT, the QT, the new SCUBA queue and the project feedback system hit the JCMT summit. Hard. At the same time, the SCUBA JCMT-OT is released to the external community. The software corridor is full of exhausted software engineers alternatively pulling their hair out, wondering when the last time they went home was, yelling "It's all totally broken!" at each other and holding off staff that seem to be in a state of shock. I only mention this because in this very same newsletter there is an [article](#) by Nick Rees suggesting we dealt with this "calmly". I assume the word "calmly" means something else in Australian.

## 2002 August

Semester 02B kicks off with a nice set of commissioning shifts to launch SCUBA observing under the OMP. The tau promptly shoots up in order to prove that the Mauna Kea weather hates software engineers as much as astronomers. It will in fact be six weeks before everything is commissioned and all staff are trained.

## 2002 September

We've been running on a commissioning schedule for what seems like centuries. I keep the team in Hilo by using the new summit support systems to telecon in to the summit, in order to stop the altitude from claiming too many software neurons as victims. The system is starting to bed in, and we've had some successes with some of the new functionality, including transparent support for orbital elements, which gets us a nice image of Pallas.

## 2002 December

The new, web-based fault system is launched across JAC. This allows the fault reporting to be integrated with the end-of-night accounting, removing much duplication, and introduces the useful ability to assign a status to filed faults. Unfortunately, the cunning ploy of trying to confuse users with a new interface fails thanks to the intuitive design; everybody finds the new system ok and the fault rate does not go down. Must try harder.

## 2003 January

We decide to keep use of the JCMT-OT for DAS observing internal for 03A, by getting external users to submit old-style templates and have the local support scientists use the OTs to create MSBs for observing. This works great for the software team as it gives us a nice long period to bed the software in and get everyone up to speed, but it means extra work for the already overworked support science staff. I am surprised I'm not getting more dark glances when I walk down the corridor, but maybe this is because everybody is busy mumbling at their screens?

## 2003 February

Semester 03A sees the dawn of flexible scheduling on UKIRT with the full deployment of the OMP at our second site. Everybody copes remarkably well with the transition, mostly thanks to the thorough

preparations by the science staff and TSSs. The software seems to hold well under the UKIRT operational model too, to our great relief. Not that I had any doubts, you understand.

#### 2003 June

Busy PI! Tired of all the e-mail the OMP sends you? Despair not! Contact information is now configurable through your project web pages, allowing you to designate one (or more) co-Is as the recipients of OMP updates.

#### 2003 July

In anticipation of Semester 03B, the JCMT-OT with Heterodyne/DAS support is released to the community. The final block is in place - all UKIRT and JCMT common-user observing is now under the auspices of the OMP. Doughnuts all around. (I'd buy them beer but half the team doesn't drink - where did I find these people?)

#### 2003 August

We deploy OMP-WORF, which allows PIs and co-Is to eavesdrop on any of their JCMT and UKIRT data as it is being taken through their OMP Web pages. This immediate effortless access to the reduced data is hoped to increase PI involvement and allow early detection on any problems with the programme. (Note to PIs: Don't dash our hopes).

#### 2003 August

We successfully test OMP/ORAC-DR integration into the [e-Star](#) network of intelligent agents during a UKIRT engineering night. This technology (scheduled for full deployment later this semester) will allow us rapid detection or follow-up on time critical and transient events, such as gamma ray burster alerts and dwarf novae monitoring programmes. It's also very, very cool.

#### 2003 September

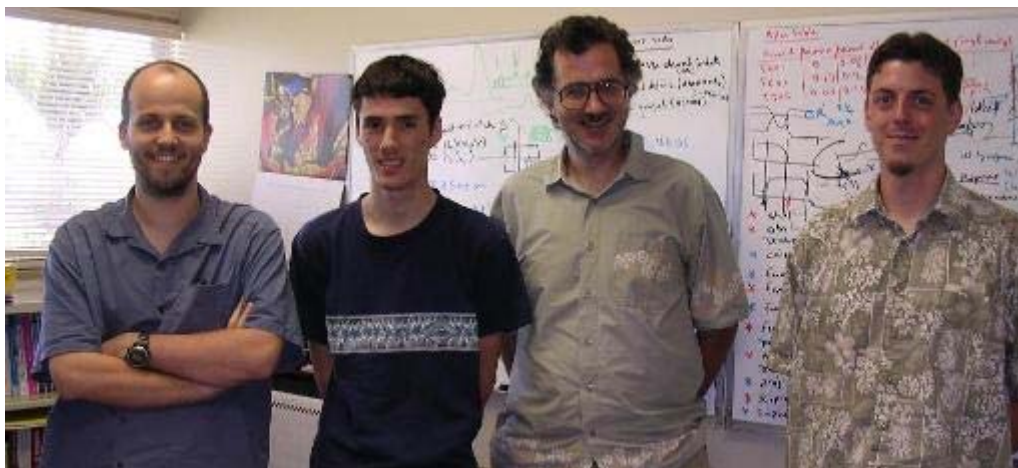
The OMP project draws to a close, and support of the delivered systems will soon pass to normal JCMT and UKIRT operations. I promptly vow never to get involved again in a project that has the word Project in its name, so as to avoid agonising for hours on how to write sentences that read "The Observational Management Project project draws to a close".

Needless to say, I am thrilled by the genuinely positive responses we have received in end-of-run reports during the last two semesters - even from the observers I forgot to bribe. I am also personally very, very proud that the team has produced such beautifully designed generic software that seamlessly runs on two completely different telescopes (and umpteen different instruments). JAC, its telescopes and their user groups will be reaping the benefits of this communality for years to come. I continue to be astonished (if not downright dismayed) that this approach has not taken hold in the larger observatory community.

Although a cast of thousands (well ok, about two dozen, but they seemed like more thanks to their endless dedication and wizzy special effects) has contributed directly and indirectly to the success of the OMP, I would like to thank the outstanding individuals in the starring roles who tirelessly toiled through nights, weekends and holidays on Yet Another Feature Request and shepherded the project through the long arduous stretch of commissioning and deployment:

- Tim Jenness (*The World Is Not Pedantic Enough*)
- Kynan Delorey (*Pirates of the Web: The Curse of the Black Perl*)
- Shaun de Witt (*The Man Who Knew Too Much Java*)
- Brad Cavanagh (*The Search for WORF*)

If only we'd given it a cooler name.



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back to:> [September 2003 Newsletter Index](#)

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Last modified: Fri Aug 29 10:30:49 HST 2003

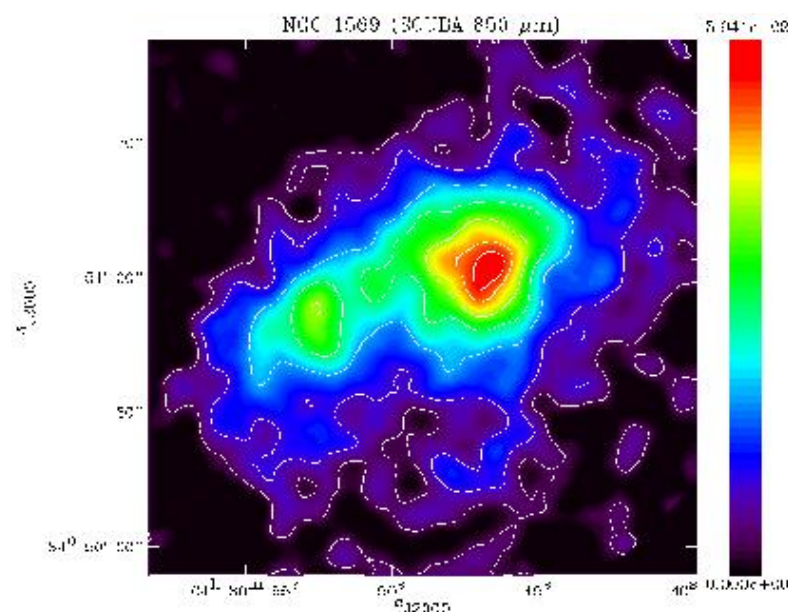
# ISM Properties in Low-Metallicity Environments II. The Dust Spectral Energy Distribution of NGC 1569

Frédéric Galliano & Suzanne Madden - *CEA/Saclay*  
 Anthony P. Jones - *IAS/Paris*  
 Christine D. Wilson - *McMaster*  
 Jean-Philippe Bernard - *CESR*  
 & Francine Le Peintre - *IAS/Paris (deceased October 2001)*

The absorption of stellar radiation by dust and its subsequent reemission in the infrared (IR) to the submillimeter (submm) is a fundamental process controlling the heating and cooling of the interstellar medium (ISM). The dust IR spectral energy distribution (SED) of a galaxy is its footprint reflecting fundamental physical parameters such as initial mass function (IMF), age, stellar population and metallicity. Thus, knowledge of the physical characteristics of dust in galaxies opens the door to understanding the star formation history and the evolution of galaxies. Dwarf galaxies in our local universe are ideal laboratories for studying the interplay between the ISM and star formation in low-metallicity environments.

In this paper, we present the complete modeling for NGC1569, a nearby ( $D = 2.2 \pm 0.6$  Mpc) dwarf galaxy with an average metallicity of 1/4 solar, currently in the aftermath of a massive burst of star formation.

## Multi-Wavelength Observations



In order to constrain the dust emission, the global observed SED of NGC 1569 was constructed, as completely as possible, from observations we obtained with SCUBA (850 and 450  $\mu$ m) and ISOCAM (4-16  $\mu$ m spectrum; Madden et al. 2003). We incorporated additional data from the literature (IRAS, KAO, ISOPHOT, MAMBO). The image presented on the left is the 850  $\mu$ m SCUBA map, tracing the cold dust continuum. Its morphology is similar to the H $\alpha$  emission.

## Self-consistent Dust Modeling

The modelling of the dust properties was done in a self-consistent manner, including the link between the stellar evolution and photoionization. We fit the IR-to-mm SED with the Désert et al. (1990)

dust model and deduced the dust emission and extinction properties. Several interstellar radiation fields (ISRF), heating the dust, were synthesized with the stellar evolutionary synthesis model, PÉGASE (Fioc & Rocca-Volmerange 1997) and constrained by the UV-to-optical SED.

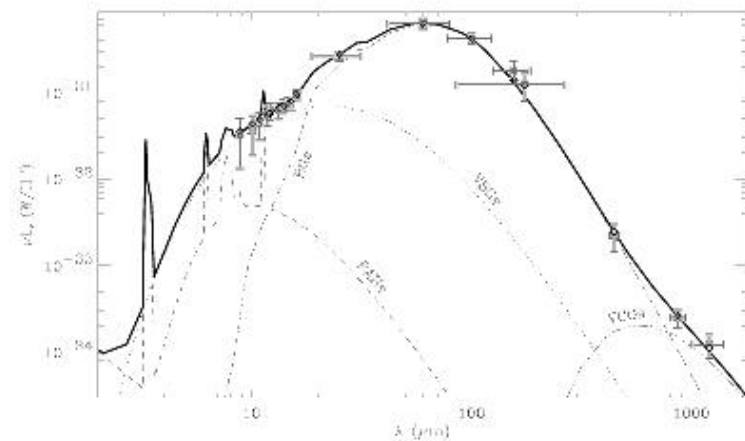
The MIR ionic line ratios from the ISOCAM spectra were used to constrain the photoionization model CLOUDY (Ferland 1996) in order to remove the degeneracy on the ISRFs found with PÉGASE. The figure on the right represents the synthesized ISRF of NGC 1569 compared to the Galactic one. The extinction curve, deduced





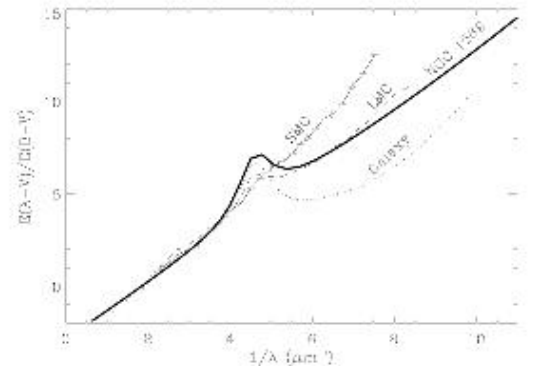
from the dust properties, was used to deredden the UV-to-optical data and this procedure was iterated on until we reached a consistent solution.

## Main results



The figure presented on the left is the final modeled dust SED of NGC 1569. The data are indicated by crosses. The lines are the dust model and its different components: **PAHs** are the carriers of the unidentified IR bands, **VSGs** (Very Small Grains) are small carbonaceous grains, **BGs** (Big Grains) are silicates and **VCGs** (Very Cold Grains) are grains modeled with a modified black body used to explain a submillimetre excess. Some new results emerge from this model:

- There is lack of PAHs which are likely destroyed by the hard radiation field combined with the low screening effects of the dust, due to the low-metallicity ISM.
- The dust emission is dominated by small grains (of radius  $\sim 3$  nm). The redistribution of large dust grains into smaller sizes is supported by the shock model of Jones et al. (1996) and is consistent with an ISM heavily influenced by supernova activity.
- The SED exhibit a submillimetre excess in emission (after subtraction of the contamination from molecular lines and radio continuum). This component which accounts for 40 to 70% of the dust mass could be produced by the presence of ubiquitous very cold dust that could hide in dense clumps in this galaxy.
- The extinction curve shown above in solid line has been synthesized for NGC 1569. It is compared to those of the Galaxy and the Magellanic clouds (LMC, SMC). The ISM of NGC 1569 has a metallicity closed to the one of the LMC. The synthesized extinction curve has a shape which is close to the one of the Magellanic clouds, with a small bump and a steep UV rise.



Moreover, we deduce a total dust mass of  $(1.6 - 3.4 \times 10^5 M_{\odot})$ . This mass is higher than what was previously found by investigators who did not take into account the submillimetre part of the SED constrained by SCUBA observations.

This article has been accepted for publication in *Astronomy & Astrophysics*.

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back to:> [September 2003 Newsletter Index](#)

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[Gerald Moriarty Schieven](#)

# SCUBA observations of GRB 030329: The brightest submillimeter afterglow to date

**I. A. Smith** - *Rice University*

**R. P. J. Tilanus** - *Joint Astronomy Centre*

**N. Tanvir** - *University of Hertfordshire*

**E. Rol & R. A. M. J. Wijers** - *University of Amsterdam*

**& C. Kouveliotou** - *NASA Marshall SFC*

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As already discussed in the [March 2002](#) and [March 2003](#) JCMT Newsletters, gamma-ray bursters (GRBs) are currently attracting intense multiwavelength studies to unravel their nature. The study of GRBs has made a significant leap forward in the last few years thanks to the discoveries of transient counterparts and quiescent host galaxies. These have shown that the bursts are due to enormous explosions taking place throughout the early Universe.

The previous Newsletter articles discussed the SCUBA observations of the host galaxies of the bursts. These measurements are usually made in good observing conditions long after any early emission from the burst itself has faded away. Their aim is to study the star formation rate in the host galaxies and to investigate the link between GRBs and massive star formation throughout the Universe.

Of equal interest is to study the early emission from GRBs. This consists of the emission from the initial explosion, and the "afterglow" that comes from the expanding fireball as it sweeps up the surrounding medium. Submillimeter observations of the early afterglows are of interest because this is where the emission peaks in some bursts in the hours to weeks following the burst. By tracking the evolving afterglow emission across the entire spectrum, it is possible to study aspects such as the types of shocks involved, the geometry of the outflow (jet versus spherical), and the geometry of the surrounding medium (uniform versus prior stellar wind).

Starting with GRB 970508, we have been performing Target of Opportunity observations of GRB afterglows using SCUBA. The goal is to observe the source as quickly as possible when the afterglow is bright, and then follow the evolution of the afterglow flux until the source is no longer detected. Unfortunately, these searches can be hampered by SCUBA not being available. The fact that they must be done quickly also means we are not always able to wait for good weather or for the source to be in an optimal location on the sky.

GRB 030329 - the burst on 2003 March 29 - was the brightest burst seen so far by the HETE satellite. The X-ray localization provided by HETE allowed ground-based optical observers to rapidly locate a bright optical transient. The redshift was measured to be 0.1685, or a luminosity distance of 880 Mpc. This is one of the closest GRBs localized to date, which is consistent with the brightness of the afterglow at all wavelengths.

Observations of the optical light curve in the days following the burst found a very complex evolution of bumps and breaks. Most interesting was the late-time appearance of a supernova, SN 2003dh, whose spectrum was similar to the Type Ic "hypernova" SN 1998bw. While the presence of supernovae has been inferred from the light curves and colors of other gamma-ray burst afterglows, this was the first direct, spectroscopic evidence that at least some classical GRBs originate from core-collapse supernovae.

Unfortunately, SCUBA was not on the telescope at the time of the burst. Although it was several days before the first SCUBA observation could be made, and the weather was not good, GRB 030329 was still easily detected as a 30 mJy source at 850 microns (Hoge et al. 2003, GCN 2088). As at other wavelengths, GRB 030329 was by far the brightest SCUBA afterglow detection to date. This source subsequently faded away, leaving no evidence for an underlying dusty host galaxy.

Observations of new bursts are continuing to produce surprises, and there is much left to learn about GRB afterglows and host galaxies. To obtain a complete picture of their nature will require the careful study of many bursts. To this end, our program of Target of Opportunity observations is ongoing. The Swift satellite - due to be launched in 2004 January - should significantly increase the number of bursts that are rapidly localized. Swift will also localize short bursts, whose counterparts have not been studied so far. Thus we should be better able to perform SCUBA observations in good observing conditions on those bursts that appear to be the most interesting.

We would like to thank the Director for supporting the Target of Opportunity GRB program. We acknowledge the sterling effort of the telescope operators who perform these observations on short notice. And we thank (and apologize to) the many observers whose programs we have bumped over the years.

For more details on this program, please see Smith et al. 1999, A&A, 347, 92, Smith et al. 2001, A&A, 380, 81, and references therein.

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back to:> [September 2003 Newsletter Index](#)

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[\*Gerald Moriarty Schieven\*](#)

# First Sub-millimetre Detection Associated with Brown Dwarfs

**R. Klein** - *MPIfEP Garching*  
**Th. Henning** - *MPIfA Heidelberg*

**& F. M. Waters** - *University of Amsterdam/Katholieke Universiteit Leuven*

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## Introduction

This is a short report on the first detection of sub-millimetre emission associated with Brown Dwarfs (BDs). It was achieved with SCUBA at the JCMT and MAMBO at the IRAM 30m telescope. The sub-millimetre emission is emitted by circum-"stellar" dust. Near and mid-infrared observations already indicated the presence of circumstellar dust around BDs by excess emission. While those observations allow conclusions on the geometry of the circumstellar matter causing the excess (e.g. Apai *et al.* 2002, ApJ, 573, L115) sub-millimetre observations enable us to assess the amount of the circumstellar matter.

The detections were achieved during observations between March 2002 and January 2003 targeting different populations of BDs. Our selection of BDs encompasses very young BDs (ages  $\sim 1$  Myr) in star-forming regions like Taurus upto very close field BDs (ages  $> 100$  Myr). In this report we concentrate on the detections of circumstellar matter around two young BDs. Full account on the observing campaign and the results is given by Klein *et al.* (2003, ApJ, 593, L57).

## Detected Dust Masses

Sub-millimetre emission associated with the BDs CFHT-BD-Tau 4 and IC 384 613 were detected consistently with SCUBA and MAMBO. The measured flux densities are listed in the table. Upper limits were derived for the other sources of the observing campaign of the order of a few mJy. The observations were executed in photometry mode using the central bolometer of SCUBA and MAMBO, respectively. The background (telluric and astronomical) subtraction was achieved by chopping with the secondary mirror and nodding the telescope. Its level has been estimated from the inner ring consisting of six bolometer pixels.

Target	Flux@850 $\mu$ m (mJy)	Flux@1.3mm (mJy)	Dust mass ( $M_E$ )
CFHT-BD-Tau 4	10.8 $\pm$ 1.8	2.1 $\pm$ 0.6	<b>1.4...7.6</b>
IC 384 613	7.6 $\pm$ 2.4	2.8 $\pm$ 0.8	<b>5.4...18</b>

The measured flux densities can be used to derive the mass of the emitting dust, since the emission is mostly optically thin. However, one needs to assume the distance to the BD, the average dust temperature, and  $\kappa_v$ , the mass absorption coefficient. Among the above quantities, the distances are well established. The distance to Taurus is 140 pc and it is 260 pc to the cluster IC 348. For dust around the young BDs, we choose a mass absorption coefficient of  $\kappa_v = 2 \text{ cm}^2 \text{ g}^{-1}$  at 1.3 mm. The same value of  $\kappa_v$  and a gas-to-dust ratio of 100 was applied by Beckwith *et al.* (1990, AJ, 99, 924) to derive disk masses for T Tauri disks. For the measurements at 850 $\mu$ m, we assume a wavelength dependence of  $\kappa_v \sim \lambda^{-\beta}$  with  $\beta=1$ , also in accordance with Beckwith *et al.*

The plausible range of dust temperatures is relatively small. We assume an average temperature of 10 to 20 K for the dust. This is the range of the mass-averaged dust temperature in the models for the disk around CFHT-BD-Tau 4 discussed by Pascucci *et al.* (2003, ApJ, 590, L111). The dust properties for the older sample of BDs have to be different (Klein *et al.*), but these are not needed here.

Applying the dust properties to the millimetre continuum measurements, we obtain the dust masses compiled in the table. The dust is certainly distributed in the form of disks as a detailed analyses of CFHT-BD-Tau 4 by Pascucci *et al.* show. The disk masses for the two BDs are 0.4...2.4  $M_J$  (Jupiter mass) and 1.7...5.7  $M_J$ , if we extrapolate the dust masses to disk masses assuming a gas-to-dust ratio of 100.

## Summary

The observing campaign targeting BDs of several populations resulted in detections of millimetre emission associated with two young BDs, on which we concentrated here. For the other targets, upper limits on the circumstellar dust mass of a few Earth masses and lower were derived from the measured upper limits on the millimetre continuum flux densities. To estimate the dust masses, two sets of dust properties had to be applied: "Young" dust properties to BDs younger than 10 Myr and "debris" dust properties to BDs older than 100 Myr. The young dust properties were presented here.

The detection of a few Jupiter masses of circumstellar matter around young BDs is an important result. To ensure this mass estimate, the dust properties have to be constrained further. However, a refinement of the dust properties will hardly change the fact that there are substantial amounts of circumstellar material around the two BDs CFHT-BD-Tau 4 and IC 348 613. Thus, the detections make BDs to places of possible planet formation. This fact opens a new set of targets for extrasolar planet searches, especially for direct imaging because of the low contrast between the central object and an prospective planet.

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back to:> [September 2003 Newsletter Index](#)

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---

[Gerald Moriarty Schieven](#)

# Measuring the Sunyaev-Zel'dovich Effect at 850 Microns Using SCUBA

**Michael Zemcov & Mark Halpern** - *University of British Columbia*

**Colin Boris & Scott Chapman** - *CalTech*

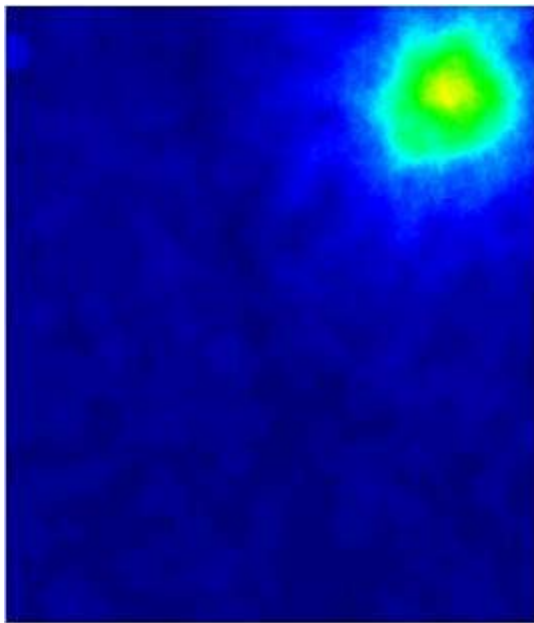
**Wayne Holland** - *United Kingdom Astronomy Technology Centre*

**Elena Pierpaoli** - *Princeton University*

**& Douglas Scott** - *University of British Columbia*

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*This article is based on papers submitted to MNRAS listed on [www.arXiv.org](http://www.arXiv.org) as astro-ph/0306300 and astro-ph/0302471. Please see those works for details not provided here, including a complete list of references.*



We report on our measurement of the Sunyaev-Zel'dovich (SZ) effect increment in two galaxy clusters using SCUBA. One of the most versatile probes of large scale structure of the universe, the Sunyaev-Zel'dovich SZ effect is an important tool for cosmologists which is difficult to measure at frequencies above 200 GHz. As the increment has been measured in only 8 clusters, our measurement is a significant addition to this field.

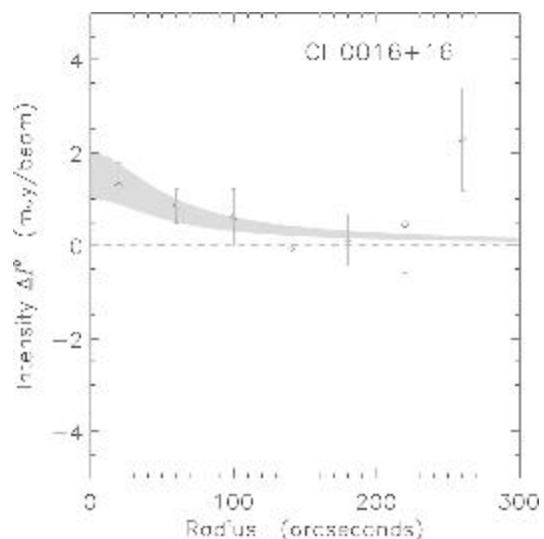
The SZ effect is caused by the interaction of low energy cosmic microwave background (CMB) photons and the high energy (approximately  $10^7$  K) electrons generally found in galaxy clusters. On average, photons gain energy from the electrons in this process. Because photon number is conserved, a characteristic change in the spectrum of the CMB as seen through the cluster results. This change manifests itself as a substantial decrease in the CMB temperature between approximately 10 GHz and 200 GHz

(called the SZ decrement) and a substantial increase in the CMB temperature between about 200 and 1000 GHz. This increase is called the SZ increment and SCUBA is well positioned to measure it.

Observations of galaxy clusters at SZ increment frequencies are important for a variety of reasons. Constraining the full spectral shape of a cluster's SZ distortion allows separation of the thermal SZ effect, which is caused by the random motions of the cluster's electrons, and the kinetic effect, which is caused by the cluster's motion relative to the CMB rest frame. This effect can be used as a probe of large scale motions and structure formation in the universe. Because the effects of CMB cooling and cosmological dimming cancel in the SZ effect, a cluster's SZ intensity is independent of redshift. This means that, unlike with other probes, structure in both location and velocity distributions at virtually any distance can be probed with multiple frequency SZ measurements.

In principle, combination of SZ data with X-ray brightness allows measurement of the cluster's temperature, electron density, pressure, and proper distance. This works well for nearby clusters. Unfortunately, this strategy becomes difficult to implement at high redshifts because X-ray fluxes become very small at redshifts greater than 1.

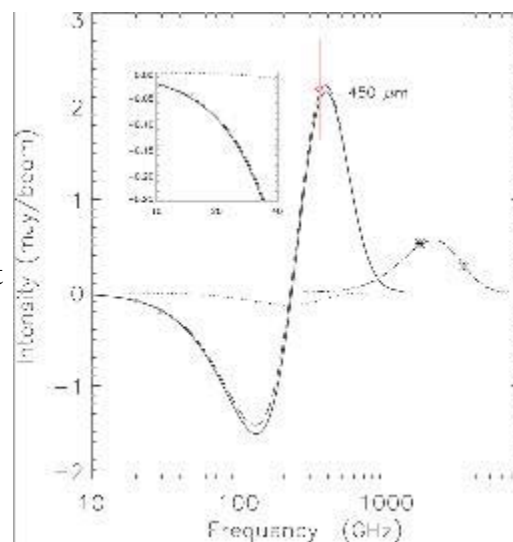




While measurements of the SZ decrement are becoming routine, detection of the SZ increment is still a challenging task. This is largely because detection of SZ emission requires sensitive instruments which can sample a wide range of spatial scales. Sub-mm instruments are beginning to make useful progress at increment wavelengths. Our group has used SCUBA to measure the SZ effect in 2 galaxy clusters. Non-standard observation and data analysis techniques are required to make this experiment a success. A large (180") chop throw is used to sample the full cluster image. We use the 650 GHz (450 micron) data to remove the effects of atmospheric emission from the 350 GHz (850 micron) data since standard, in-band atmospheric corrections would cancel the SZ intensity. JCMT's high resolution allows us to reject possible point source contaminants which plague SZ measurement with smaller

instruments. We fit the SZ amplitude directly to our measured data rather than fitting to a map made from the data. As a check for point source contamination, we also fit the data to an annular model. Measurements are made of control fields which should give null results to check these methods.

The result for CIG 0016+16 is shown in Figure 1 (above left), where the grey band shows the fit of the time stream to the extended emission profile, and the points with error bars are determined by fitting to an annular model. We have also performed Monte Carlo simulations in an attempt to understand the effects of confused sources on our measurement. It is found that the likelihood of obtaining our result due to confused point sources if no SZ increment were present is less than 1%. After correcting the model fit value for the effects of atmospheric subtraction, the result shown in red in Figure 2 (right) is obtained. This can be combined with decrement measurements (inset) to limit the peculiar velocity to  $v_{pec} = 400^{+1900}_{-1400}$  km/s via the kinetic effect (dotted line). We are currently analyzing the data from a number of cluster fields in the hopes of placing useful limits on the 350 GHz intensity for many of them.



This work shows that with a carefully designed experiment, the JCMT/SCUBA combination can be used to provide robust measurements of the SZ effect. It is hoped that it will be possible to use SCUBA 2 for similar measurements which will compliment the many upcoming SZ experiments working at other wavelengths.

back to:> [September 2003 Newsletter Index](#)

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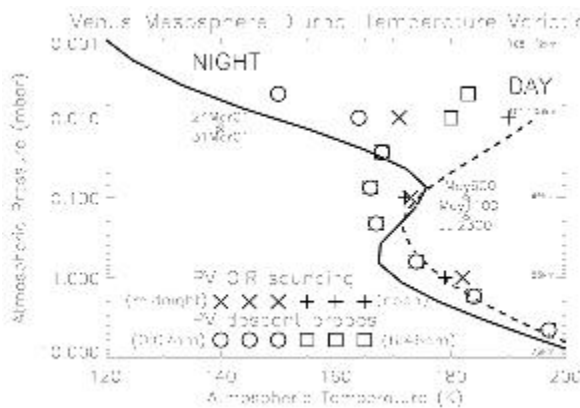
# Observations of the the Venusian Mesosphere

Brad Sandor - *Space Science Institute*

R. Todd Clancy - *Space Science Institute*

& Gerald Moriarty Schieven - *Joint Astronomy Centre*

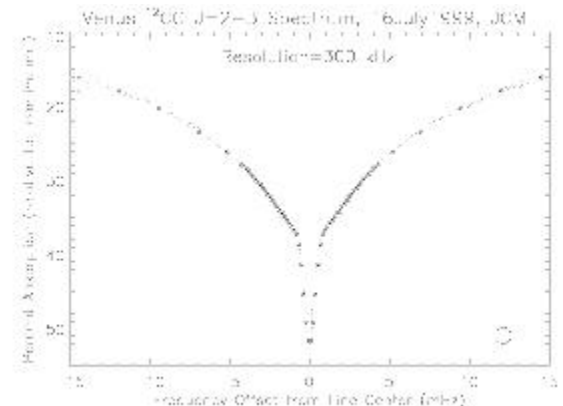
The massive Venus atmosphere presents extremely inhospitable conditions, ranging from crushing pressures (equivalent to ~ 1km ocean depths) and searing temperatures (hot enough to melt lead) at the surface, to thick sulfuric acid clouds extending over 40-60 km altitudes above the surface. The circulation of the lower Venus atmosphere is characterized by global east to west (zonal) winds, which peak at 70-100 m/sec velocities within the acid clouds. Above these cloud layers, both the chemistry and circulation of the atmosphere change significantly in character. Solar ultraviolet flux drives sulfur, chlorine, and hydrogen catalytic cycles critical to the formation of the lower sulfuric acid clouds and the stability of the Venus atmosphere to CO<sub>2</sub> photolysis. Enhanced levels of CO within the Venus mesosphere (at 60-110 km altitudes) result from dayside photolysis of CO<sub>2</sub> (the primary gas constituent of the Venus atmosphere) above the sulfuric acid cloud region. In addition, the general circulation of the Venus atmosphere transitions from the zonal rotation of the lower atmosphere below and within the mesosphere to a dominant solar-to-antisolar (SAS) flow (Dickinson and Ridley, 1980) above the Venus mesosphere.



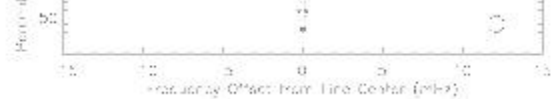
Millimeter spectral line observations have played an important role in investigation of the poorly constrained Venus mesosphere, due to relatively strong transitions for CO in this wavelength region and the pressure-broadened lineshapes of these absorptions, which support vertical profile retrievals of temperature and CO as well as Doppler wind determinations. Millimeter spectral line observations have shown large nightside enhancements (>200% relative to dayside) in CO abundances above 90 km altitudes (Gulkis et al., 1997; Clancy et al., 2002). This CO diurnal variation is driven by SAS-driven transport within and above the mesosphere of

Venus, but the complex and apparently unstable transition between the zonal and SAS circulation leads to global-scale variations on uncertain timescales. Combined measurements of optically thick <sup>12</sup>CO and optically thin <sup>13</sup>CO millimeter lines constrain both the CO mixing ratio and temperature profile, a technique which has been employed to determine surprisingly large secular variations in Venus nightside mesospheric temperatures (40 K at 90-100 km altitudes- Clancy and Muhleman, 1991) and CO distribution.

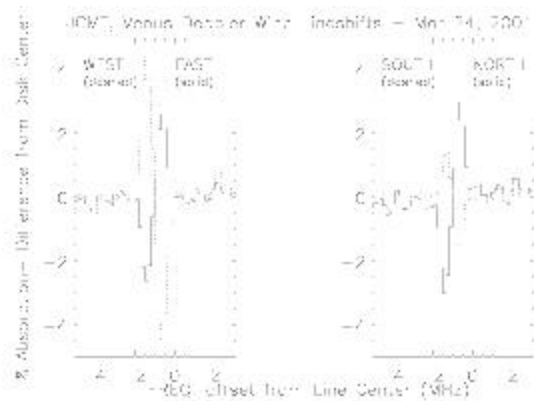
JCMT measurements of sub-mm CO spectra yield much improved temperature profiling due to the increased line optical depths, and so have provided the first definition of a global diurnal variation in upper mesospheric temperatures, and the presence of a dayside mesopause at 90-100 km altitudes (figure 1 above left, from Clancy et al., 2003). Sub-millimeter observations from JCMT also offer critical improvements to Doppler wind measurements: very narrow, deep absorption lines (figure 2 right) for much improved wind sensitivity (figure 3 below left); and higher spatial resolution







(smaller beam size), which greatly reduces the effects of geometrical and spatial smearing across the Venus disk. We have pursued JCMT mapping observations of 330 and 345 ghz CO line absorptions, for four separate weekend periods centered on Venus inferior conjunctions in 2001 and 2002. Venus presents its maximum angular diameter (~60 arcsec) and a full range of nightside local times at inferior conjunction, which occurs roughly every 1.5 years. Consequently, we were able to retrieve winds, CO, and temperature profiles of the nightside mesosphere with extensive local time and latitudinal coverage, and over a range of diagnostic timescales. The improved sensitivity and temporal sampling of these sub-mm CO observations prove critical to defining a chaotic circulation regime for the upper mesosphere.



Previous disk-resolved millimeter observations of CO line Doppler winds around Venus inferior conjunction have implied conflicting results for mesospheric circulation at 90-110km altitudes, corresponding to interpretations for both predominately zonal (Shah et al., 1991) and predominately SAS (Lellouch et al., 1994) circulation in this region. Our 2001 and 2002 JCMT observations of the Venus nightside mesosphere show that both distinct circulations, accompanied by characteristic temperature differences, were present at these separate times (by 1.5 years). In addition, there are surprisingly large variations in the global wind, temperature,

and CO mixing distributions between consecutive days and weeks within each observing period, although the basis circulation character (zonal vs. SAS) remained intact. We do not understand the full implications of this time variability, but it appears that the Venus mesosphere is one of the most dynamically unstable atmospheric regions observed in the solar system. For such a temporally dynamic system, a long-term record of diagnostic, self-consistent observations is critical for analysis. Spacecraft have not regularly observed the Venus atmosphere since the 1980s, and orbiting observatories such as HST preclude Venus observing due to solar direction pointing restrictions. In this regard, earth-based observing of Venus over many years with an especially sensitive and diagnostic platform such as the JCMT is the primary method of advancement for study of the remarkably dynamic Venus atmosphere.

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back to:> [September 2003 Newsletter Index](#)

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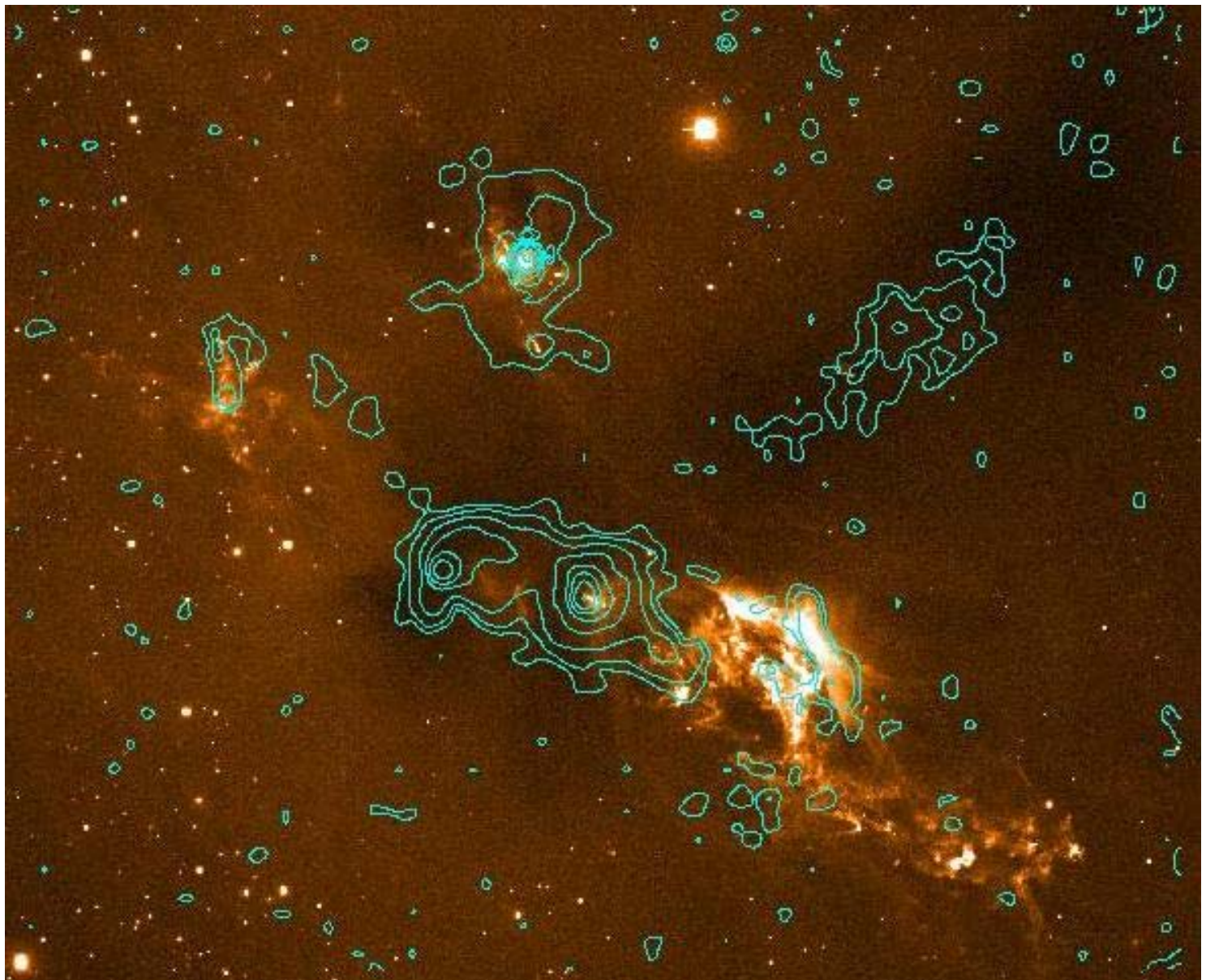
# SCUBA Image of the L1551 Starburst Region

Doug Johnstone - *Herzberg Institute of Astrophysics, National Research Council of Canada*>

**Gerald Moriarty Schieven** - *Joint Astronomy Centre/National Research Council of Canada*

**& John Bally** - *University of Colorado*

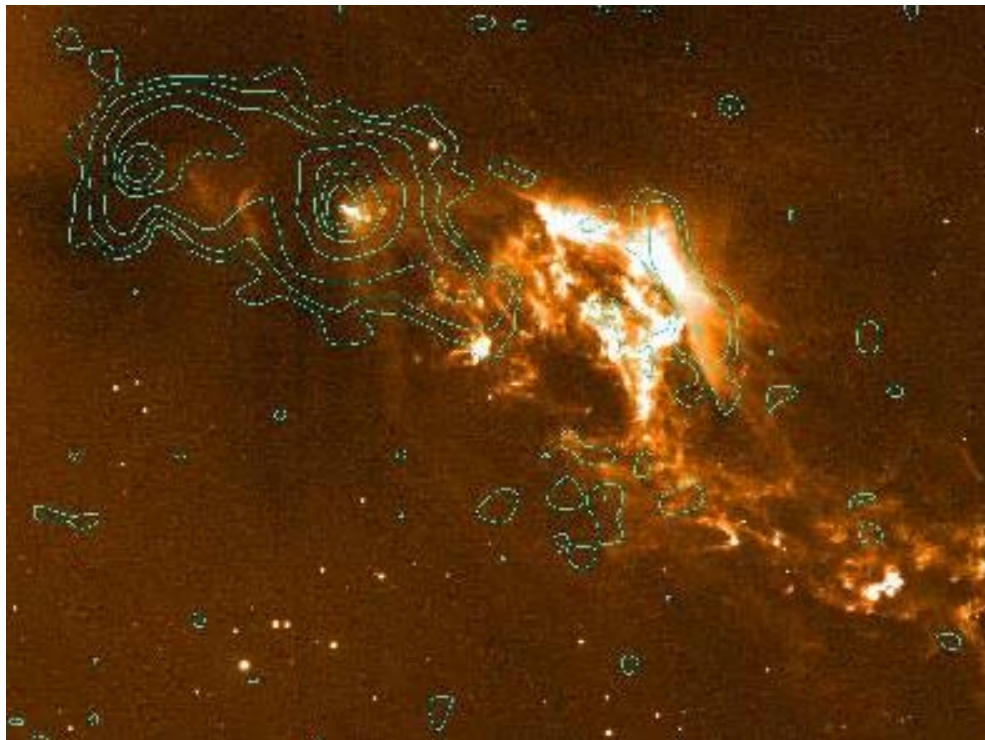
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*SII image of the L1551 region with contours of 850 $\mu$ m emission overlaid.*

The Taurus molecular cloud complex, one of the closest star-forming regions at 140pc, is well-known for its low star-formation efficiency, and sparse low-mass stars. The exception is the L1551 dark cloud which is the nearest, one of the best-known, and well studied region of low mass star formation. This 40 M<sub>sol</sub> dark molecular cloud contains at least one class 0/I protostar (L1551 NE), the archetypical class I outflow source (L1551 IRS5), several T Tauri (class II) stars including HL/XZ Tau, and weak T Tauri (class III) stars including UX Tau. Indeed, X-ray observations have identified at least 38 young stars in the L1551 cloud.. The large number of young protostars in a small region is more reminiscent of a starburst cloud like the  $\rho$  Ophiuchi complex, than the rest of the Taurus cloud complex.

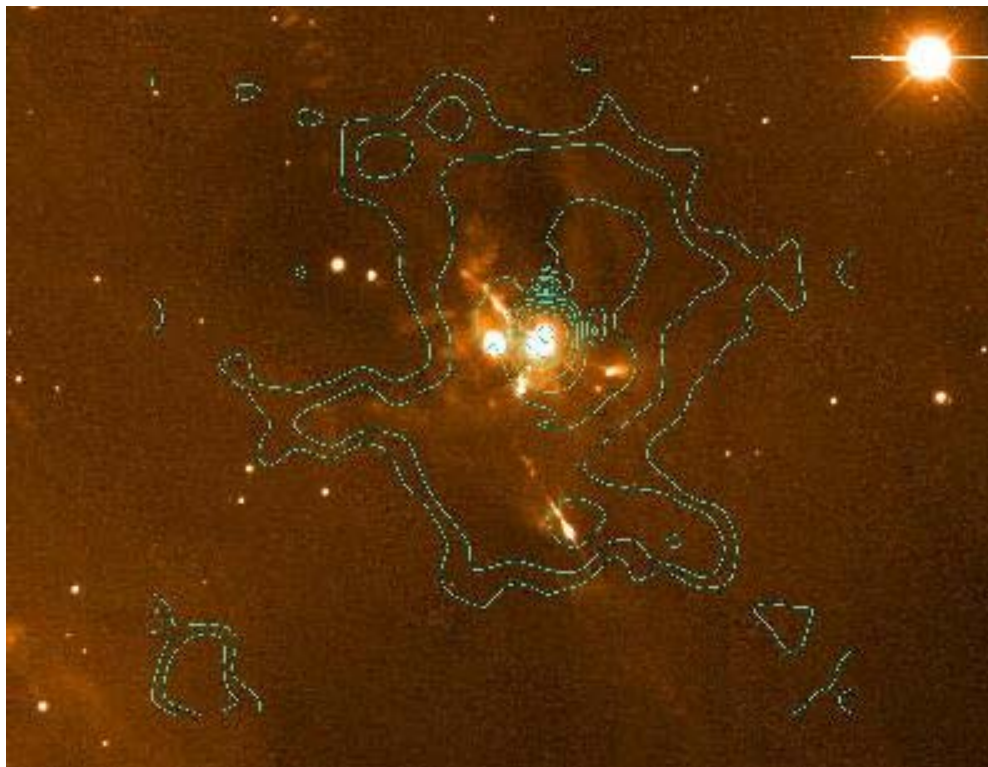


Many of these young protostars are very active. Three (or possibly four) bipolar molecular outflows are known, including the archetypical L1551 IRS5 flow, at least two jets emanate from the cluster around HL Tau, and strings of Herbig Haro objects have been determined (through proper motion studies) to originate from several

sources.

Nevertheless, this extremely active and well-studied region has not been the subject of a large-scale SCUBA study. We have mapped a 20'x20' centered on IRS5. In addition, because IRS5 is often used as a pointing source and HL Tau is one of our secondary calibrator sources, we used data mining to extract *all* SCUBA data of this region ever taken from the archive and included those in our data reduction. Image reconstruction was done using the matrix inversion method described by Johnstone et al (2000, ApJS, 131, 505), and large-scale (and probably unreal) ripple was removed using unsharp masking.

The amount of structure visible in the image is remarkable. Above left is a close-up of the L1551 IRS5 region (full size click [here](#)). The two continuum peaks are L1551 IRS5 (right) and L1551 NE (left). The IRS5 outflow also shows up in 850 $\mu$ m in select regions, particularly at a strong bow shock. To the right is a close-up of the HL/XZ Tau region.



Analysis of these data is in progress, and a paper is in preparation.

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back to:> [September 2003 Newsletter Index](#)

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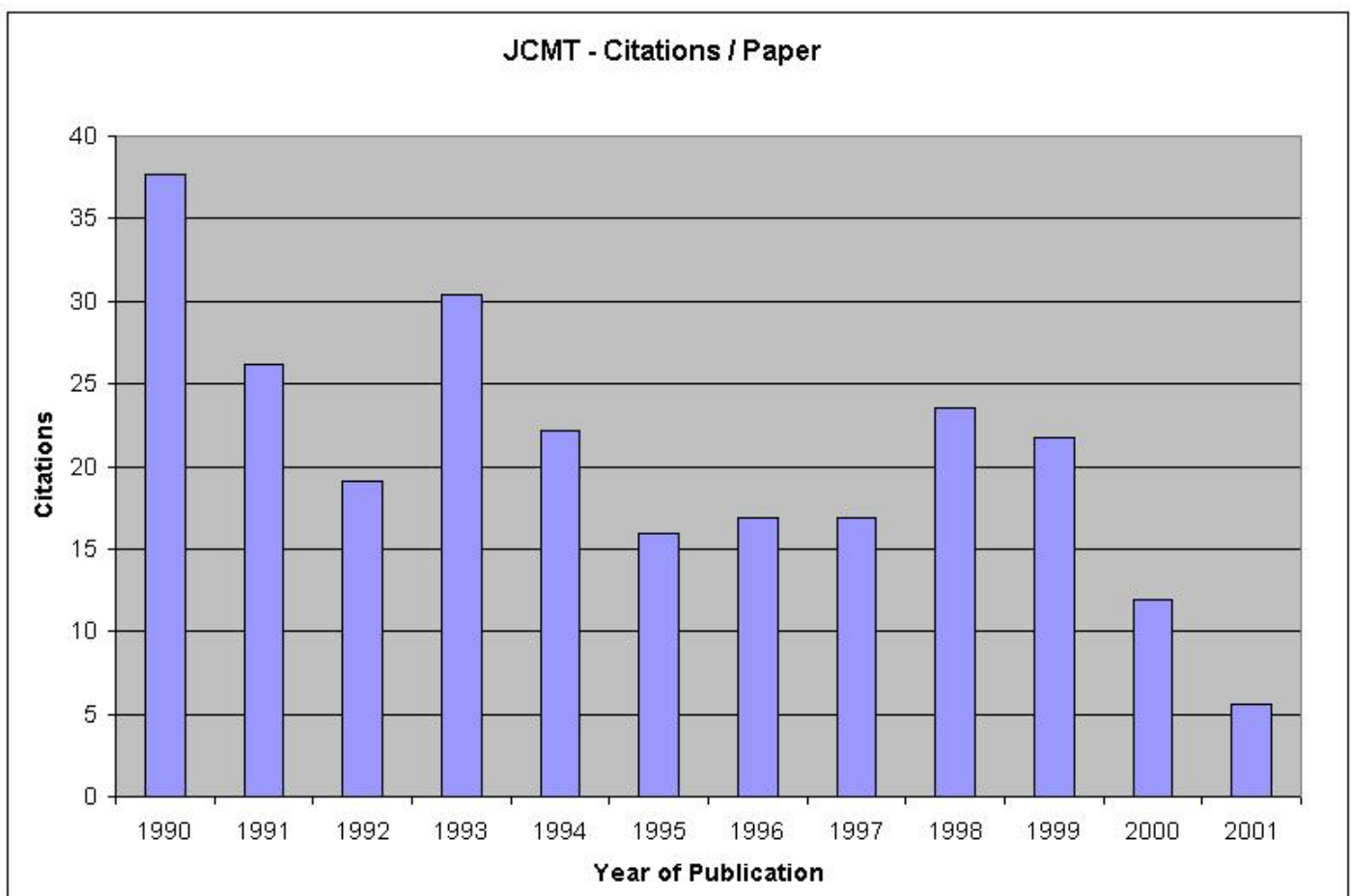
# JCMT Citations 1990-2001

**Dennis Crabtree** - *Herzberg Institute of Astrophysics/National Research Council of Canada*

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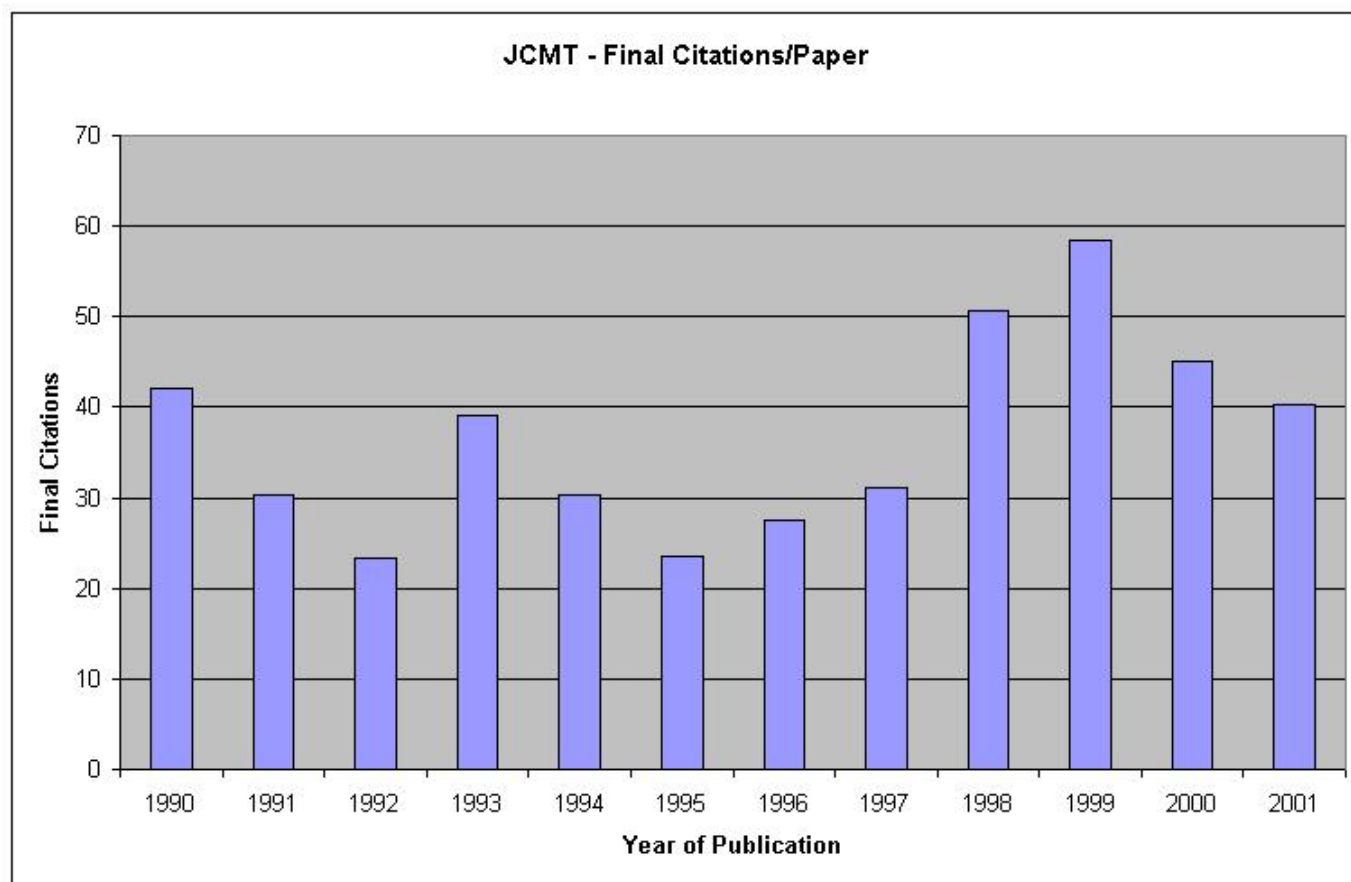
Citations are a commonly used, and often controversial, metric of scientific work. Lies, Damned Lies and Citations! Citation information is simply that — information. This information needs to be carefully considered before drawing any meaningful conclusions. While the number of papers published is a measure of productivity, citations are often referred to as a measure of impact. I like to think of citations as measuring the relevance of the research to what others are doing.

I have been maintaining a database of observatory publications that includes the JCMT telescope among others. This database also includes citation counts that are retrieved from NASA's Astrophysical Database System (ADS). The standard source of citation information is the Institute for Scientific Information (ISI) Science Citation Index. The big advantage of the ADS is that the citation information is free and available via a Web interface. The ADS citation numbers are different from the ISI ones as ADS does not include citations from a number of physics journals and they do include citations from conference proceedings. Crabtree and Bryson (2001) found that the ADS and ISI numbers agree to about the 5% level. Besides the raw citation numbers I also use "final" citation numbers. These are the predicted number of citations a paper will have after 20 years. These numbers are estimated from an average growth curve for CFHT publications (Crabtree and Bryson 2001). The "final" citation numbers are useful when comparing an ensemble of papers published in different years as the number of citations for papers grows naturally with time. While far from perfect, I've found this a very useful approach when comparing average citation counts across many years.



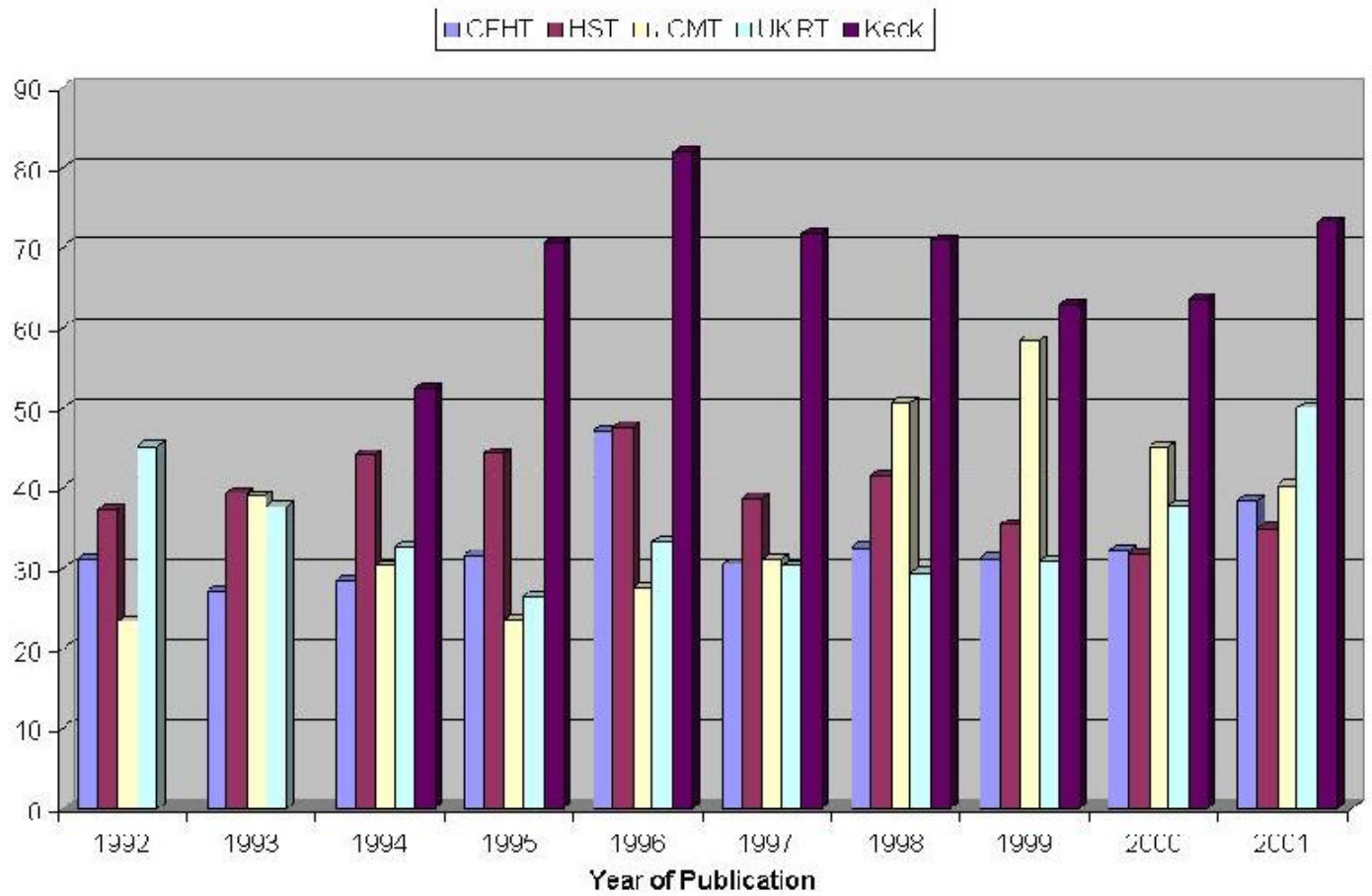
This first figure shows the average citations/paper for JCMT publications between 1990 and 2001. One can see the expected trend of increasing citation counts for older papers. The second figure shows the "final" citations numbers which removes this average trend. Clearly evident starting in 1998 is what I call the Scuba Bump. The average citation rate for

JCMT papers jumped significantly because highly cited SCUBA papers were being published.



As mentioned, I also have a number of other telescope publications in my database. The third figure shows how JCMT compares to these other telescope between 1992 and 2001. Again, the tremendous impact of SCUBA papers is readily visible. Note how the average citation rate for JCMT is higher than that of HST. HST pumps out a lot of papers, many of them highly cited. However, on average, a recent JCMT paper receives as many, or more, citations.

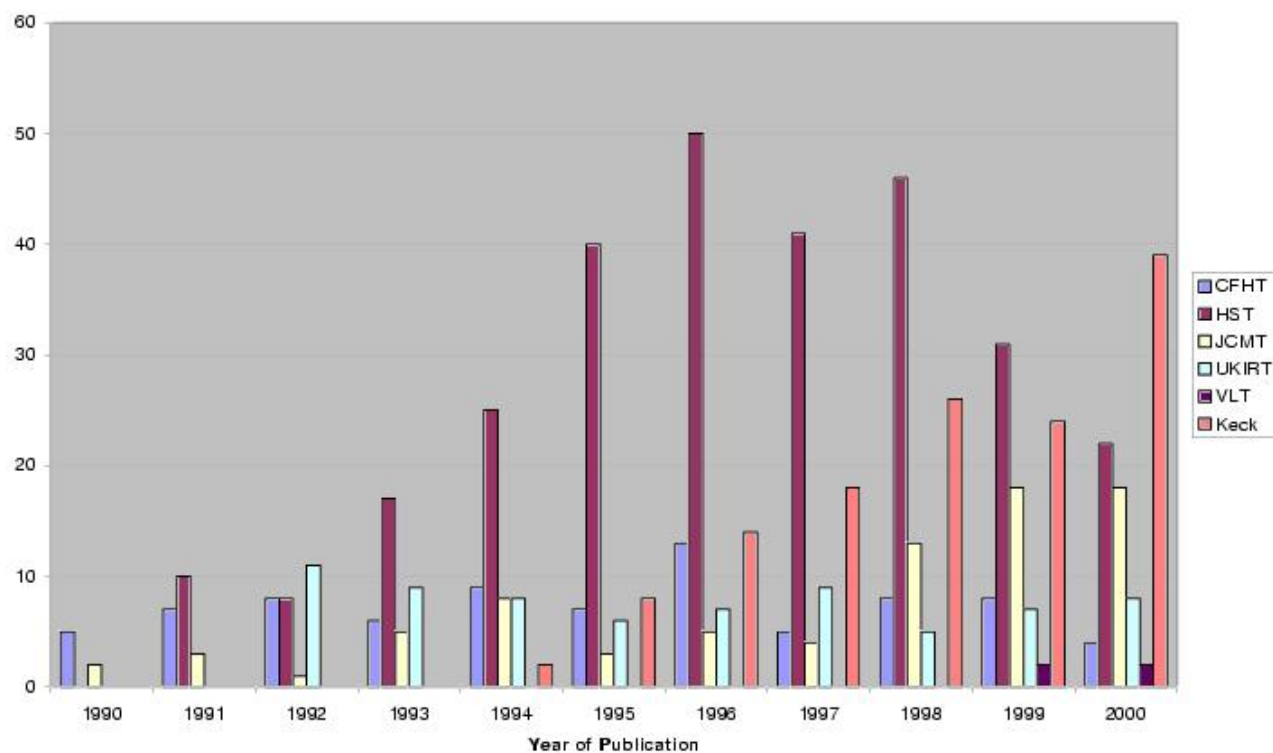
## Final Citations/Paper



I've retrieved the 500 most cited papers from the ADS for several years and can count the number of papers from each telescope in the "Top 500" for each year.



Number of Papers in the ADS Top 500



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back to:> [September 2003 Newsletter Index](#)

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[Dennis Crabtree](#)