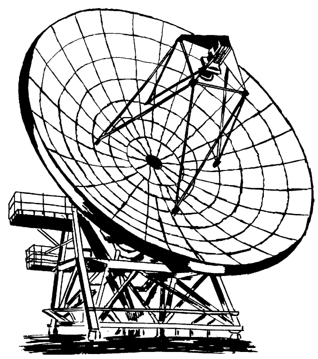
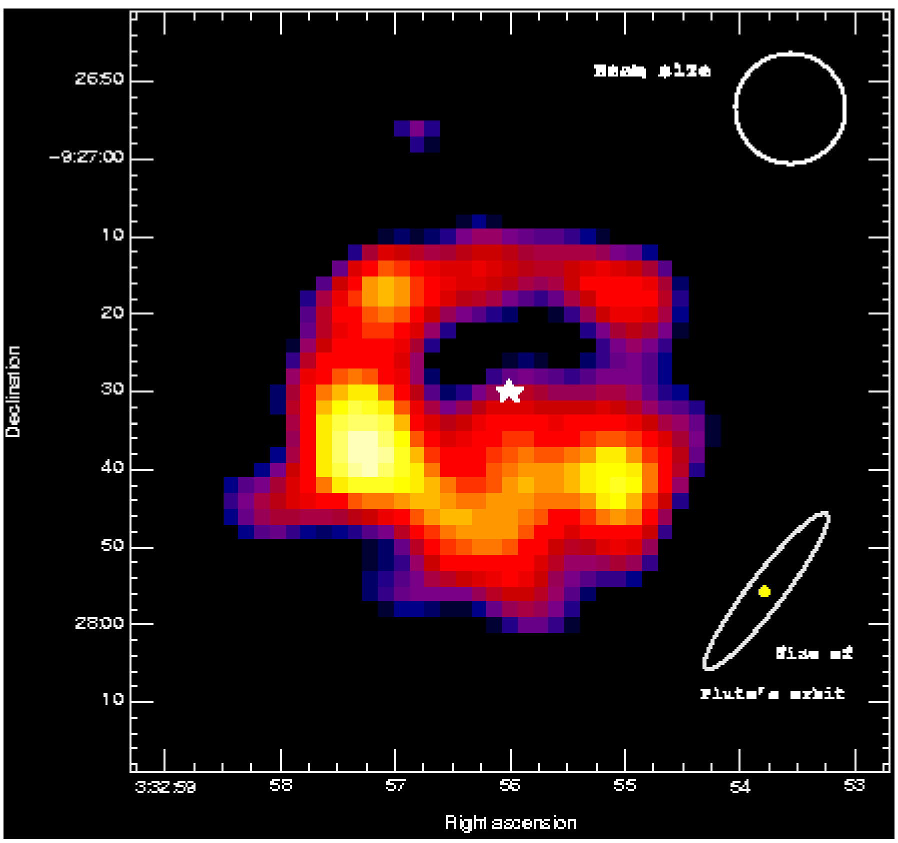


The JCMT Newsletter

Kulia I Ka Nu'U

Number 11

September 1998



INDEX TO THIS ISSUE

- Message from the Director
- The People Page
- Announcement for Semester 99A Applications

INSTRUMENTATION UPDATE

- Heterodyne Instrumentation
- SCUBA
- Short Baseline Interferometry
- South Pole Imaging Fabry-Perot Interferometer (SPIFI)

PATT INFORMATION

- PATT Application Deadline
- Special Notes 99A Applicants
- Electronic Submission Update
- PATT ITAC Report for Semester 98B

STATISTICS

- Weather and Fault Statistics for Semester 98A
- Publication Statistics

TECHNICAL NEWS

- The JAC Safety Manual
- The 1997 JCMT Annual Report
- An Early Start to Evening Shifts
- Service Mode Acknowledgements
- Modifications to the UK (and International) Service Observing Application Procedures
- SCUBA Chop Tracking Bug

SCIENCE HIGHLIGHTS

- SCUBA discovers a Distant Galaxy hidden in Dust
- Possible new Solar System in formation around nearby stars Vega and Fomalhaut
- JCMT discovers a Nearby Star System just like our own Solar System
- SCUBA Observations reveal Distant Star-forming Galaxies obscured by Dust
- JAC Internal Science Seminars

CONTACT INFORMATION

- Points of Contact

ABOUT THE NEWSLETTER

- Next Submission Deadline
- About this Newsletter

Message from the Director

Since the last Newsletter a number of SCUBA observations have made front-page news (at least in the USA) and have demonstrated the wonderful ability of the instrument to revolutionise submillimetre astronomy in good weather conditions. A lengthy period of exceptional weather since mid-December through May resulted in a number of highlights which can be found elsewhere in this letter. Most notable of these in terms of changing our previous views of the topic were: dust disks around nearby main-sequence stars (Holland *et al.* Nature, **392**, 788, 1998), the amazing dust disk around Epsilon Eridani (Greaves *et al.*, Ap.J. in press); a number of very deep observations of what we believe to be star-forming galaxies in the early Universe (*e.g.* Hughes *et al.* Nature **394**, 241, 1998, Barger *et al. ibid.* p248). These latter results confirm the earlier measurements of Smail, Ivison and Blain (Ap.J., **490**, L5, 1997) and show that optical-UV data have seriously underestimated the star-formation rate at redshifts beyond z=2. Although continuing to work well, one or two niggling problems still remain with SCUBA and pose a drain on staff effort for other projects.

With the arrival of RxW the JCMT is almost up to full strength of instruments - we just await RxA3i and the upgrade to the D-band mixers for RxW. The ACSIS project is going well and continues on-schedule.

Much work has been undertaken over the summer to prepare proposals for the JCMT Advisory Panel and Board meetings in November for two main instrument projects: the two heterodyne array cameras, currently called the HARP project and slated to be at B-band (already agreed) and most probably D-band; and a project to improve the sensitivity of SCUBA. The papers for the Advisory Panel will be sent to members especially early this time in order to give the community chance to comment on the above two (and any other) proposals.

I am also hoping to get additional funding for further JCMT instruments/developments from the sale of unused JCMT Hale Pohaku rooms to other telescopes. If this is successful a call will go out through the JCMT Advisory Panel for suggestions.

The telescope continues to operate well although very recently, following a surface adjustment (which may or may not be related) there have been anomalies noted in both the pointing and the beam pattern of the antenna. Adequate calibration should ensure these do not pose a problem for observers but work is in-hand to determine their origins and fix them. The central bearing replacement is scheduled for the spring of 1999.

One of the points that is apparent to me from personal experience is that it is still very difficult for both observers, TSSs and even support astronomers to select backup proposals when the weather is too poor for the primary SCUBA proposal. This has been apparent for some months and although we have put a significant effort into its solution, I am afraid we are still somewhat struggling to keep up with the book-keeping task of which observations have been done on a programme. There is also a very distinct lack of simple (but scientifically valuable) A-band backup proposals covering a wide range of RAs in the pipeline. A new project (Observing Management Project) designed to utilise the observing database is now in-hand. This will match the observations undertaken at the telescope with the approved programmes and observing templates and will give an automatic update of progress on the programmes. This will greatly assist in the book-keeping of the use of telescope time and the selection of which observations to undertake in real-time at the telescope by observers who are undertaking backup observations. However, it is not scheduled for completion until sometime next year. In the meantime, I ask for patience from observers. We are well aware of the problem and are working on it. Software effort is, in general, in very short supply, but I am pleased to announce that the SCUBA pipeline processing has been tested and is about to be released to users.

However, please note that there is a definite need for scientifically exciting and observationally easy-to-do A-band backup proposals that can be undertaken by the TSSs if necessary when the SCUBA (in particular) dry-weather programmes cannot be undertaken.

Users should note that the past few months have been very difficult for the JCMT. Following the inability of the funding agencies to increase the JCMT operations budget in-line with inflation, the build-up of this problem over the last three years came to a head at the May Board meeting with the result of a number of non-voluntary staff losses. Two of these are in the support astronomer area and so it is with regret that I must inform the community that we will not be able to give as high a level of support as in previous times. However, with the Observing Management software system installed, the new modes of flexible observing using longer stays by visiting astronomers, and as more users gain experience with SCUBA and RxW, this should, in time, alleviate some of the lost capability.

The JCMT Review, looking at how the JCMT should develop in the latter half of the next decade, is now scheduled for either later this year or in the spring of 1999 with a report to the May meeting of the Board. The Panel Members will be soliciting views from their constituents.

Ian Robson,
Director JCMT
8th September 1998

The People Page

Wendy Light has been appointed as JAC Head of Administration.

Dwight Chan has been appointed as JCMT Electrical Engineer.

The following member of staff has left the JAC recently and we would like to extend our thanks and appreciation for all his hard work on behalf of the JAC, and wish him every success in the future.

Lorne Avery departs in early September back to HIA, Victoria. Lorne has been at the JCMT for the past three years hoping to get some scientific research done. However he was given the new RxB3 to calibrate and maintain and this has managed to take up the vast majority of his time. In addition to many mountain trips (quite often at weekends or during holidays) to ‘fix’ or ‘patch’ RxB3 into operation Lorne has spent considerable effort towards getting a comprehensive catalog of spectral line standards into shape with simple access tools for all heterodyne observers. Lorne will remain in frequent contact with the JCMT since he goes back to HIA to become Head of the JCMT Group on the retirement of John MacLeod.

There will be 4 new University of Victoria students working at the JAC between September and December -

Dimitri Marinakis will be working on the conversion of the existing Panel adjuster VME micro Drama software with Ian Smith. This work will enable the micro to control the pending replacement panel adjuster electronics.

Pam Shimek will be assisting Remo Tilanus and Tim Jenness on the Observation Management Project. She will be working on tools to assist with flexible scheduling on the JCMT.

Patricia Smith and **Paul Geddes** will be under the direction of Ian Pain working on a range of design tasks including Upgrades work (staff lounge ceiling insulation and/or Dome cooling and HVAC) and support (translation mount, etc), operations support and documentation improvement.

INSTRUMENTATION

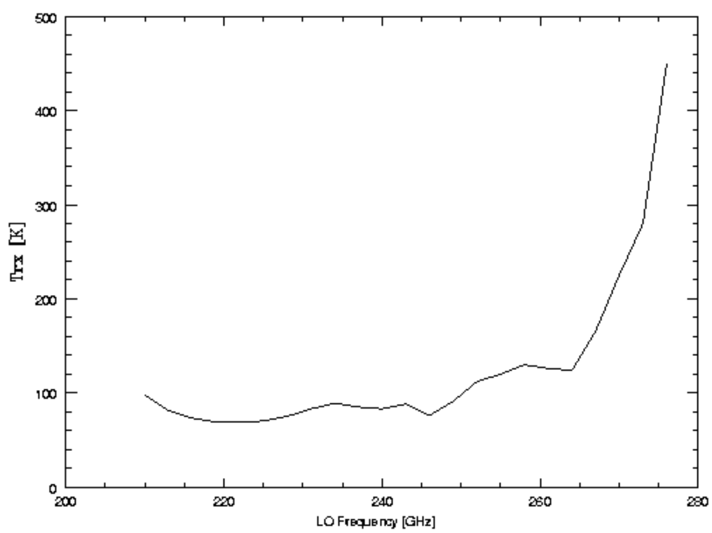
Heterodyne Instrumentation

The current state of the JCMT instruments, their availability on the telescope and their sensitivities and other observational parameters can always be located on the relevant pages within the JCMT World-Wide Web site. All the relevant details were reproduced in complete detail in the downloadable version of Newsletter number 10 and are reproduced in a shortened form below. They will not be included in subsequent Newsletters unless significant changes have been made to a particular instrument.

Fact Sheet for the 230 GHz Band (RxA2)

- This version of the receiver has been installed in the telescope since November 1996.
- Single channel SIS receiver operating in DSB mode.
- Frequency coverage 210 to 265 GHz. It can be tuned up to 275 GHz but with poor performance.
- Predicted zenith system temperatures at 230 GHz. The CSO tau meter gives the zenith opacity at 225 GHz (τ_{225}).

	$\tau_{225} < 0.05$	$0.05 < \tau_{225} < 0.1$	$0.1 < \tau_{225} < 0.2$	$\tau_{225} < 0.5$
T_{sys}	< 300 K	300 K – 350 K	350 K – 450 K	< 800 K



T_{rx} of RxA2 as function of LO frequency

- Efficiencies

η_{beam}	$0.79 - 5.5\ 10^{-3}\ (\nu[GHz]-200) + 3.9\ 10^{-5}\ (\nu[GHz]-200)^2 \pm 0.04$
η_l	0.91 ± 0.01
η_{fss}	0.80 ± 0.05
η_A	$0.78\ \eta_{beam}$
HPBW (arcsec)	$19.52\ (245.0 / \nu[GHz]) + 0.47 \cos(0.2428 * \nu[GHz]+3.6064) \pm 0.5$

Please address any comments, suggestions or requests to: Per Friberg
friberg@jach.hawaii.edu

Fact Sheet for the 345 GHz Band (RxB3)

- Frequency coverage 300 to 380 GHz.

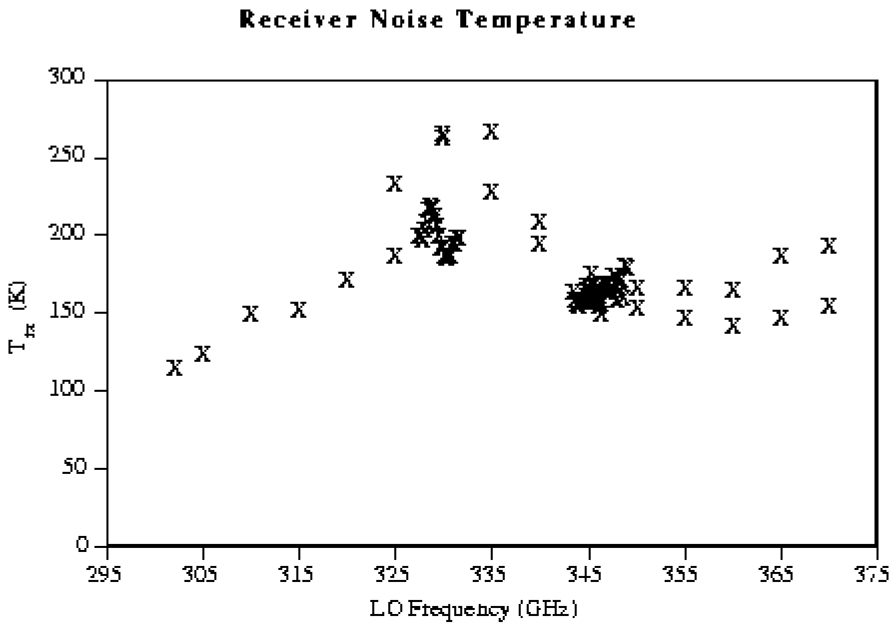
- Predicted zenith system temperatures at 345 GHz. The CSO tau meter gives the zenith opacity at 225 GHz (τ_{225}).

	$\tau_{225} < 0.05$	$0.05 < \tau_{225} < 0.1$	$0.1 < \tau_{225} < 0.15$	$\tau_{225} < 0.25$
T_{sys}	< 600 K	600 K – 800 K	800 K – 1000 K	< 1600 K

- Efficiencies

η_{beam}	0.60 ± 0.02 (Jupiter) 0.59 ± 0.03 (Mars)
η_l	0.91 ± 0.02
η_{fss}	0.7 ± 0.1
η_A	0.41 ± 0.05
HPBW (arcsec)	$14.3 * (340.0 / \nu[GHz]) \pm 0.5$

The present values have applied since May, 1996.



T_{rx} of RxB3 as function of Lo frequency

Please address any comments, suggestions or requests to: Per Friberg
friberg@jach.hawaii.edu

Fact Sheet for the 460/490 GHz Band (RxC2)

- Single channel SIS receiver operating in DSB mode.
- Frequency coverage 450 to 505 GHz.
- Predicted zenith system temperatures at 462 and 492 GHz. The CSO tau
- meter gives the zenith opacity at 225 GHz (τ_{225}).

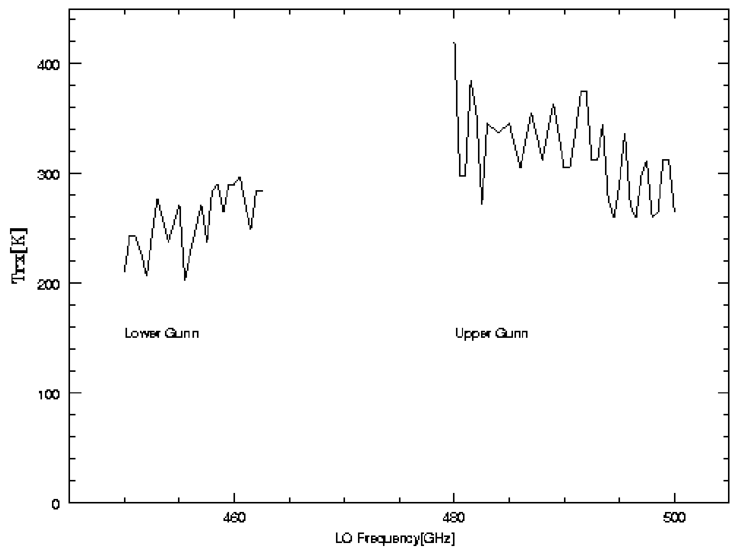
	$\tau_{225} < 0.03$	$0.03 < \tau_{225} < 0.05$	$0.05 < \tau_{225} < 0.075$	$\tau_{225} < 0.1$
T_{sys} (462)	< 1200 K	1200 K – 1700 K	1700 K – 2600 K	< 4000 K
T_{sys} (492)	< 1900 K	1900 K – 3200 K	3200 K – 5700 K	< 10000 K

- Efficiencies

η_{beam}	0.53 ± 0.05 (Mars)
η_{l}	0.88 ± 0.03 (462 GHz) and 0.78 ± 0.05 (492 GHz)
η_{fss}	0.7 ± 0.1
η_{A}	0.42 ± 0.05
HPBW (arcsec)	10.57 * (475.0 / ν[GHz]) ± 0.5

- The beam and aperture efficiency will decrease during daytime when the antenna is warmer. Beam efficiencies down to about 0.30 have been recorded at the start of first shift and the end of second shift.

- Due to very limited calibration data obtained in 1997 it is very important that efficiency observations are performed as part of your program.



T_{rx} of RxC2 as function of LO frequency

Please address any comments, suggestions or requests to: Per Friberg
friberg@jach.hawaii.edu

RxW

General information

Receiver RxW will be ready for general use in Semester 99A. It is a dual channel receiver that operates roughly between 430 - 510 GHz (C-band) and 630 - 710 GHz (D-band). The actual tuning range might be slightly different. Updated information about the tuning range and other parameters will be published on the web when available.

RxW was built by MRAO with the D-band mixers supplied by SRON. The receiver actually has four mixers - 2 at C-band and 2 at D-band. However, the optics only allows one pair of mixers to be used at any given time. Further the LO system only supports use at one frequency at any give time. Thus the receiver is a dual channel C-band or D-band receiver with no mixed mode available. The receiver is normally operated in Single SideBand (SSB) mode with the unwanted sideband terminated on a cold load. However, Dual SideBand (DSB) operation is possible. The tuning is partly automatic. The LO chain still needs to be tuned manually by the TSS while mixers and diplexers are tuned remotely. Switching between C- and D- band also is manual.

As might be apparent from the above the commissioning of the receiver is not finished. The receiver arrived in Hawaii early June this year. However, the commissioning has been delayed by several problems. First and most severely by a failure of the compressor which operates the receiver's closed cycle cooler.

Further there has been problems with the optical alignment, electronics and software. The most severe remaining problem is a wiring fault inside the dewar affecting a HEMT used for the D-band. Thus only one D-band channel is currently operating.

We are confident that all remaining problems will be solved before the start of the Semester 99A. The receiver will also be available for general use during the fall (latter half of Semester 98B) on a best effort basis. However, we do anticipate at least two periods when the receiver will be warm and not available. It should also be noted that until the end of the commissioning not all receiver parameters will be known and users need to measure efficiencies as well as check calibration carefully. Whenever new or revised information is available it will be placed on the web.

Current performance

Efficiency:

The beam efficiency measured on Jupiter is about 0.5 at C-band and 0.3 at D-band.

Beam size:

Not yet available.

Pointing:

The current relative pointing offset between the two channels at C-band is:

channel (B - A) Az: -0.9"+/-0.2" El: 1.0"+/-0.2"

The relative pointing between the channels at D-band has not been measured after the last alignment. However from earlier data the relative pointing offset is believed to be close to the C-band values.

Noise temperatures (SSB):

Frequency	Sideband	A-channel	B-channel	Line
(GHz)		T_{rx} (K)	T_{rx}(K)	
430.00	LSB	420	290	
461.04	USB	300	300	CO 4-3
461.04	LSB	330	340	
492.16	USB	340	340	CI
508.53	USB	330	490	
630.00	LSB	----	3000	
636.53	USB	1400	1700	
661.07	USB	1100	1100	^{13}CO 6-5
691.47	USB	1100	1100	CO 6-5

The current SCUBA sensitivities

The current Noise-Equivalent Flux Densities (in mJy/rtHz) per pixel in the SCUBA filter bands are as follows.

Measured sensitivities

Wavelength (microns)	Best NEFD	Average NEFD	Notes
2000	120	120	Remains unchanged from previous measurements
1350	60	60	Remains unchanged
1100	-	-	Not usable at present
850	75	90	Remains unchanged
750	110	140	Better characterised – slight improvement
450	450	700	Remains unchanged
350	1000	1600	Improved by new filter (see note)

Note : New 350 micron filter was installed in November 1997. The new NEFDs are not well characterised, and as with 450 microns, depend very significantly on the dish surface accuracy.

Please address any comments, suggestions or requests to: Wayne Holland **wsh@jach.hawaii.edu**

SCUBA

The SCUBA homepage has recently been updated concerning latest developments and information regarding applications for semester 99A.

Applying for observing time in Semester 99A

The next deadline for JCMT applications is 30th September 1998. This note describes some of the technical considerations applicants should be aware of when applying for SCUBA time.

1: General information

As for previous semesters there are again no time restrictions either per source or per proposal. Accepted proposals will most likely be flexibly scheduled in blocks, with designated observers performing the observations. Short programmes, requiring less than a shift (8 hours) will be probably be done in serviced mode, although depending on resources the observations may not be done by JCMT staff, but astronomers from the user’s country. International proposals in this category will normally be undertaken by staff astronomers.

2: Which observing modes are available?

There will be four basic observing modes available for semester 99A -

- Photometry
- Jiggle-mapping
- Scan-mapping
- Polarimetry

For observations with the arrays, applications will be accepted for photometry at 450:850 microns simultaneously, 350:750 microns simultaneously, or any combination **separately**. Mapping applications (both jiggle and scan map) will be accepted for 450:850 or 350:750 simultaneously. There is no advantage in asking for maps at individual wavelengths separately since the data at the other wavelength comes automatically. It should be noted, that because of the NEFDs, observations at 350:750 are generally much more time consuming than those at 450:850.

Applications will also be accepted for photometry or mapping with the 2000 and 1350 microns photometric pixels. The 1100 micron pixel is currently unavailable. The photometric pixels look out simultaneously but are offset from each other on the sky, so simultaneous photometry is not possible. Mapping is obviously very inefficient with the photometric pixels compared with the arrays, and should be restricted to small areas (i.e. less than about 2 arcminutes square for jiggle-map, and 3-4 arcminutes for scan-map).

3: Current system sensitivities

The current NEFD per pixel remains largely unchanged from the previous announcement, except that some limited observations have shown a noticeable improvement in NEFD at 350 microns (a new filter was installed in late November 1997). The current NEFDs per pixel are shown earlier in this newsletter. These numbers may improve in the near future, particularly at the shortest wavelengths, with an improvement in the dish surface accuracy.

Sensitivity, particularly at the shorter array wavelengths (350 and 450 microns), depends very much on the weather, but also on the elevation of the source. The table of sensitivities indicates the best sensitivity achieved in each filter, i.e. under very good conditions and close to zenith. Also included in the table are figures that we believe are more representative of ‘average’ conditions. In calculating integration times it is also necessary to take into acount the average elevation of the source during the proposed observation.

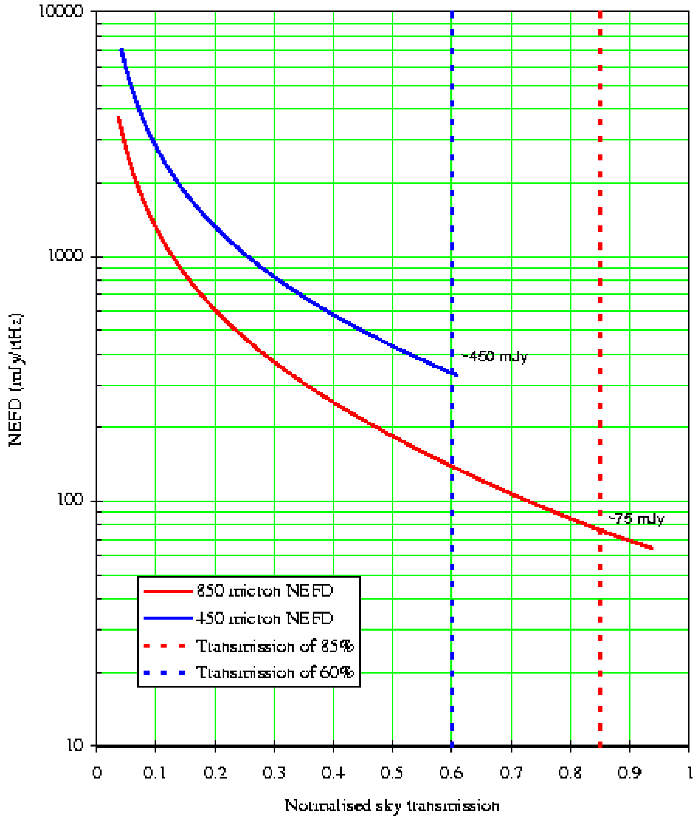


Figure 1

Figure 1 shows a plot of the expected variation of NEFD at 850 and 450 microns with sky transmission, where the sky transmission is simply exp(-tau.airmass), and so observing at low elevations on a very good night is equivalent to observing at high elevations on a poor night. The two vertical lines correspond to the best transmissions at 850 microns (0.15) and 450 microns (0.6). For 'average' nights the zenith optical depths (tau) are around 0.22 (850) and 0.8-0.9 (450). The form of the variation for 750 microns is similar to 850, and likewise 350 microns is very similar to 450. For the photometric pixels (1350 and 2000 microns) the variation is essentially ignored, except under very poor conditions.

We have provided a new Web-based observing tool to assist with the calculation of integration times. The Integration Time Calculator can be accessed on the Web and more details are given in section 5 below.

4: Which observing mode to use?

It may seem an obvious statement, but the observing mode you choose depends on precisely what you want to do!

*   **Photometry -** If you have a completely isolated point source, with a known accurate position, then the **photometry** mode is your best bet. If you want 850 micron photometry then 450 comes for free (even if you don't detect it at 450), and similarly, 350 microns comes for free with 750. However, if you suspect your source might be slightly extended, OR you are interested in the field around

your source, OR your position isn't very reliable, then you should almost certainly take a map.

* **Jiggle mapping** - When it comes to mapping there are two basic options: jiggle-mapping and scan (or raster) mapping. **Jiggle mapping** is the preferred mode for sources that are smaller than the array field-of-view. Limited mosaicing of jiggle maps is also possible, although care must be taken to avoid chopping onto extended emission. To obtain a fully-sampled map using the jiggle method requires taking data at 16 positions (see Figure 2). Therefore, the sensitivity per sampled point is 1/4 that of a point-source observation for the same integration time. However, this is only true if you wish to retain the full spatial resolution of the map. On many occasions you are most likely interested in the total flux of an object (eg. an unresolved core in a map), and in such cases you can afford to bin pixels (i.e. degrade the resolution) in order to gain signal-to-noise.

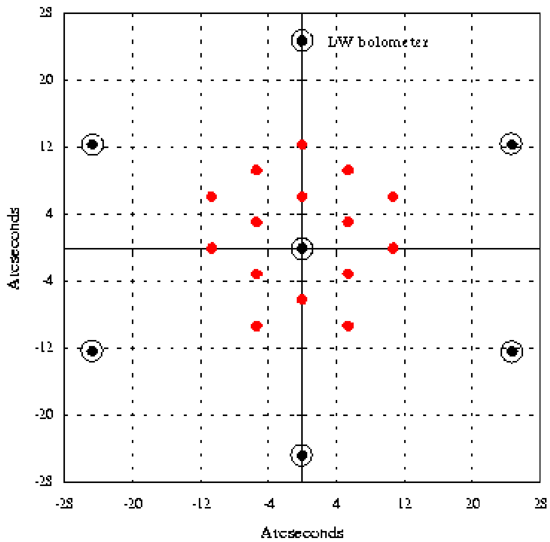


Figure 2: *Jiggle 16 mapping*

For example, for a perfectly pointed observation a calculation using the measured SCUBA beam profiles suggests that if you add together the signals measured on a point source over the 16 positions (1 second at each) of a jiggle-map, we would get a S/N approximately 3 times worse that if we'd simply sat on the peak for 16 seconds. In reality, there is always a residual pointing error for stare photometry, plus the effects of seeing to take into account, and tests during commissioning have shown that under good conditions the S/N on a point source is 2 - 2.3 times lower with a jiggle map than with photometry. If the seeing is poor, OR if the source is slightly extended, then the difference is smaller, and the two modes may even be comparable. In such circumstances it may be better to take a fully-sampled map rather than photometry. **However, it should be pointed out that by binning pixels together you are degrading the resolution of your map.**

* **Scan mapping** - The **scan-map** mode is the preferred mode for sources that are bigger than the array, and works particularly well for sources in confused regions. This mode works in a similar way to the old 'on-the-fly' raster mapping with UKT14, but, of course, we have an array rather than a single pixel.

The telescope moves the array in a raster pattern across the source, and as with jiggle-mapping, integrations can be coadded to improve the S/N. As the telescope is scanning the secondary mirror is also chopping and measures the difference in signal between two points a short distance apart (typically 30-60 arcseconds). Full image sampling along the scan direction is achieved by adjusting the scan rate and sampling frequency. One demodulated data sample is obtained for each cycle of the secondary chopper, so if the chop frequency is 7.8125 Hz (as currently used for scan map), a 3 arcseconds spacing (to produce fully-sampled maps at 450 and 850 microns) will be produced by a scan rate of 24 arcsec/second. We arrange the direction of the scan such that the bolometer rows cross the region at an angle shown in Figure 3, so that one single scan fully samples the map area. The black dots represent the bolometer positions for the Long-Wave array, and the slight distortion from a true hexagon shape is because of field curvature caused by the SCUBA optics. This technique has the disadvantage that it fixes the angle of the scan on the sky, so we cannot expect to scan in azimuth. Although sky rotation has a minimal effect on the sampling for each scan across the map area, it may cause the edges of successive maps not to butt together correctly. There is no real cure for this in the current system, so we allow an substantial overlap of the array between scans and between maps.

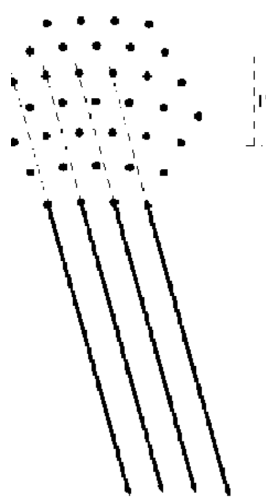


Figure 3

In Semesters 98A and 98B we have adopted a new method for acquiring scan map data, known (locally) as the ‘Emerson2’ technique. This method is described in detail by Jenness et al. (SPIE Vol. **3357**, 1998, in press). The technique reduces the severity of some of the problems associated with the traditonal EKH restoration, and results in a significant improvement in S/N. It is not necessary to know exactly how this new method works to write your proposals, but if you are interested please refer to the link on the Web page. An effective method of removing sky noise from scan map data is currently under development and should be available for semester 99A.

One obvious question that one may ask concerns the relative merits of jiggle and scan map for particular types of observation. If you have a source smaller than the array field of view, and are confident of chopping onto ‘blank’ sky, then jiggle map is almost always the preferred mode. It is fair to say (and we have proven this empirically) that if you used both observing modes to map, say, a 8 arcminute long edge-on galaxy (where the width of the galaxy is < 1 arcminute), then mosaicing jiggle maps will almost certainly always give a lower noise level for the same effective integration time. This is most likely due to residual low-level noise from the restoration of scan map data. This may change as we become more experienced in the use of the scan map observing mode. However, for large, roughly circularly-symmetric sources (bigger than the field of view), or sources in confused regions, then scan map is probably your best bet.

* **Polarimetry -** The SCUBA polarimeter was successfully commissioned in October 1997, and will be offered again in Semester 99A. Observations can be made at all SCUBA wavelengths, using either the ‘array’ waveplate (350-850 microns) or the ‘photometric’ waveplate (1350,2000). Limited array mapping has been successfully used already during Semester 98B, and for Semester 99A we are intending to release full-imaging polarimetry in jiggle-map mode (with some caveats). For more details, including some of the latest results, see below and also access the SCUBA Polarimeter web page.

5: Calculating integration times

Calculating integration times for the various SCUBA observing modes has never been easier! We now have an Integration Time Calculator (ITC) available on the Web for use in writing proposals. The following sections detail the calculations included in the ITC, as well as containing some examples.

(i) Photometry

For photometry the rms noise (in mJy) after t seconds is simply NEFD/sqrt(t).

As an example, consider we have a point-like source that we think is around 50 mJy at 850 microns (the flux estimate may have come from an extrapolation from other wavelengths). We would like, say a 10-sigma detection on this source, and so the integration time required is :

$$t = \left[\frac{NEFD}{F}\right]^2 \sigma^2$$

where F is the estimated source flux (in mJy) and sigma is the signal-to-noise ratio . So, using the ‘average NEFD’ of 90 mJy at 850 microns (the ITC will allow a more accurate value to be used), means that we would require 324 seconds to give a 10-sigma detection.

Similarly we can invert the above equation, and find that in one-hour integration time we should reach a rms noise level (1-sigma) of 1.5 mJy/pixel. In 8 hours (i.e. one-shift of telescope time) we can expect to achieve close to 0.5 mJy. A table of the sensitivity limits (1-sigma) for the average achievable NEFDs is given below for 350, 450, 850 and 1350 microns.

When carrying out photometry using one of the array wavelengths, it is possible to chop between 2 bolometers on the array. This would mean that no time is ‘wasted’ looking at blank sky during the chop cycle. This has still not been tested extensively, although it has been used in semester 97B. It is available for semester 98B with some caveats.

Wavelength (μm)	NEFD (mJy/√Hz)	1-hr (mJy)	10-hrs (mJy)	25-hrs (mJy)
350	1600	27	8.4	5.3
450	700	12	3.7	2.3
850	90	1.5	0.5	0.3
1350	60	1.0	0.3	0.2

Table of SCUBA sensitivity limits

Such a refinement should theoretically gain you a factor of 2 in integration time (or 1.414 in noise). However, the chop will most likely not be in azimuth, since the bolometer are arranged in a hexagon. Further complications arise because of the field curvature aberration caused by the SCUBA optics. This means that while chopping between 2 bolometers works fine, chopping between 3 bolometers as required for the full nod cycle, does not work properly (since the bolometers do not lie on a straight line). From the (very) limited tests we have performed so far the improvement in noise is more like a factor of 25-30% on a single chop cycle. Applicants are asked NOT to include this potential gain in their calculations, *unless it is absolutely essential to make the programme feasible*. In addition, if this mode is deemed suitable to a particular programme by the JCMT support staff, then it may be used to improve the S/N.

(ii) Jiggle mapping

As mentioned above jiggle mapping requires taking data at 16 positions to produce a fully-sampled map.

Therefore, in this case the time estimate for a fully-sampled map is:

$$t = 16\left[\frac{NEFD}{F}\right]^2\sigma^2$$

When we use both arrays simultaneously we adopt a 64 position jiggle pattern (see Figure 4). This is usually split into 4 sets of 16, and after each 16 jiggles (each jiggle takes one second) the telescope is nodded. However, the integration time calculation is still the same, since we sample at around 3 arcsecs. This ensures that we cover the same area between the LW array bolometers, at the resolution required by the SW array (since the spacing of the SW bolometers is about half that of the LW). So at 850 microns we are effectively oversampling by a factor of 4.

As an example, consider a map of say a 1 arcminute core, which we again estimate has a peak flux of about 50 mJy. We would again like 10-sigma on the peak and so using the above equation we would require an integration time of 1.44 hrs, or obviously 16 times longer than our point-source photometry. Again, as mentioned in section 3, if you are intending to bin pixels (i.e. degrade resolution) then the factor of 16 in the above equation can be dropped to around 4-5.

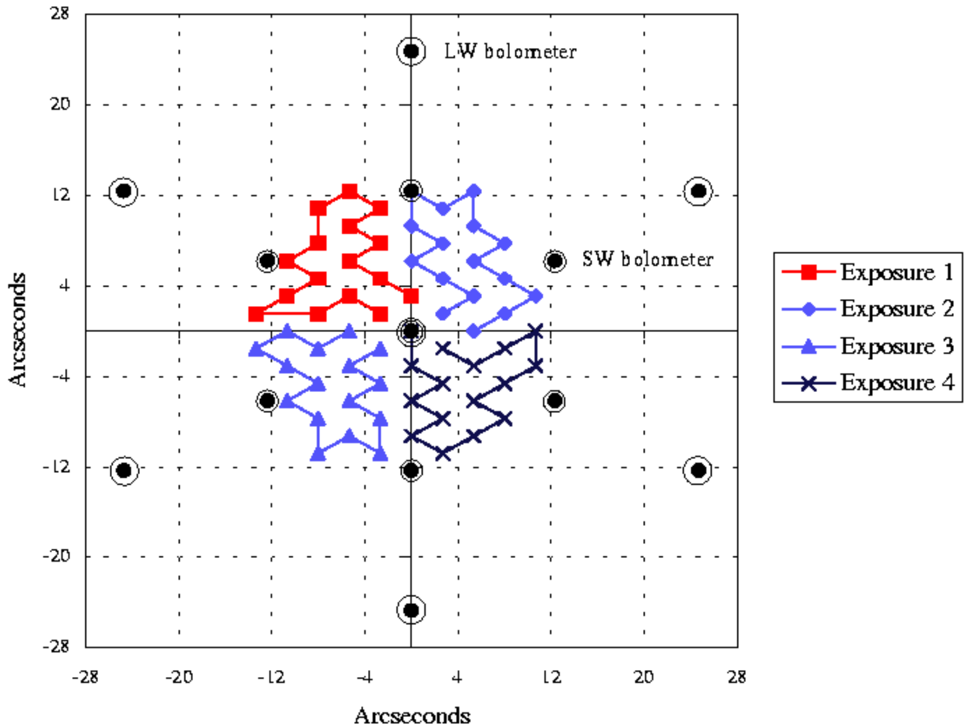


Figure 4: *A 64 position jiggle pattern.*

(iii) Scan mapping

Scan mapping is a relatively new mode for SCUBA, and we are continually improving the efficiency (eg. by cutting down on the overheads - see section 6). The following equation has been found to work satisfactorily for estimating scan map integration times:

$$t = \frac{(x+L)W}{d^2N}\left(\frac{NEFD}{F}\right)^2\sigma^2$$

where L is the length of the map in the scan direction (in arcseconds), W is the width (arcseconds), d is the pixel resolution required (arcseconds), and N is the number of array elements. To ensure that we produce a fully-sampled map of the selected area we conservatively allow an overlap of half the array diameter at the beginning and end of each scan. Hence there is a factor, x (equal to 138 arcseconds) which needs to be added to the length of a scan.

Consider an example: Suppose we wish to scan-map a 10 x 10 arcminute region, with the default 3 arcsecond sampling. The brightest source in the image is estimated to be about 300 mJy at 850 microns, and we would like at least 10-sigma on this peak. Using an NEFD of 90 mJy/rtHz, the above equation gives an integration time of 3.3 hr. However, you have to remember that in sampling at 3 arcseconds we are effectively oversampling by a factor of 4 at 850 microns, and so a scan map to produce an rms noise level of 30 mJy would therefore take about 0.8 hr (plus overheads, as discussed in section 6). Depending on the spectrum of your source you might do better or worse (usually worse!) at 450 microns. For example, if the source described above had a ν-squared spectrum the signal-to-noise at 450 microns (NEFD of 700 mJy) would only be around 3.5 for the same integration time.

(iv) Polarimetry

The default mode for carrying out polarimetry observations will be the 'step-and-integrate' technique (similar to the way that the UKT14 polarimeter used to operate).

To obtain a polarisation signal-to-noise, sigma_pol, for a source of flux, F, it is necessary to integrate for the following time:

$$t = 18\left[\frac{NEFD.\sigma_{pol}}{p.F}\right]^2$$

where p is the expected percentage polarisation level. This equation assumes that 16 waveplate positions will be used in the data acquisition, which was generally the preferred mode of taking data with the old UKT14 polarimeter. The equation also includes losses in transmission due to the wire grid and waveplate itself. A full derivation of this expression is available on the Web.

Consider a couple of examples: Suppose we have a 1 Jy protostar, for which we estimate a polarisation level of about 2%. To obtain a 5-sigma detection, at 850 microns, under average conditions would take about 2.5 hrs. Now consider a 0.2 Jy blazar, which may be typically 5% polarised. To obtain a 5-sigma detection at 1350 microns would take about 4.5 hrs.

6: Estimating overheads

Although we have made significant progress in reducing some software overheads, there are still substantial overheads to be added to the above integration times for *all observing modes*. There are two types of overheads: 'observational overheads' which are associated with the setup and carrying out of a particular observation, and 'calibration overheads', which includes pointing, focussing, slewing, skydips and other calibration (eg. beam maps). The ITC now calculates the observational overheads for you.

For 'observational overheads' here are a few examples: A 10 minute on-source photometry observation currently take about 15 minutes in total, i.e. an overhead of 50%. If you programme consists of photometry observations of this type (or even shorter integration times), then the total overhead, to include calibration and slew times, should be more like 100%. So for every 4 hours applied for, you should add another 4 hours to the time requested.

For jiggle mapping, it again depends on the length of the observation, but typically one might map for a longer time eg. 30-60 minutes at a time (if the weather allows). A 40 minute jiggle map typically takes about 52 minutes total time, and so the overhead is only about 30% (this is mainly because the time between nods is longer than for photometry). You should probably add another 50% for calibration, giving a total overhead of closer to 80%.

Scan mapping still has a large observational overhead which we are hoping to improve. At the present time we estimate that this will be something like 50% for semester 98B proposals. Again, an additional 50% for calibration should be added, giving a total overhead of approximately 100%.

For polarimetry the overheads involved in moving the waveplate are quite high. Calibration is not so critical in polarimetry (unless you are trying to measure the source flux as well as the polarisation level!), and so the overall overheads are likely to be around 100% again.

Good luck with your proposals! Please address any queries to Wayne Holland **wsh@jach.hawaii.edu**

SCUBA Polarimeter

The SCUBA Polarimeter will be offered again in Semester 99A. Observations can be made at all SCUBA wavelengths, using either the `array' waveplate (350-850 microns) or the `photometric' waveplate (1350, 2000 microns). Note that changing the waveplate is time-consuming, so you should not plan to do this during an observing shift.

Imaging polarimetry using the full arrays will be released for this semester. This means the full 2.3 arcmin field of view of the arrays can be used. The primary observing wavelength will be 850 microns (with 450 micron data obtained simultaneously). Note that the imaging polarimetry mode depends on a successful commissioning period in late 1998. Several nights will be used to characterise the instrumental polarization, primarily for all 37 long-wave pixels at 850 microns. This task is currently 40% complete, and has been problem-free. However, a complete set of 850 micron instrumental data cannot be absolutely guaranteed for observations in 99A (and 450 micron data will be limited).

Single-pixel polarimetry observations can be made routinely at all SCUBA wavelengths.

Scan map polarimetry is NOT offered this semester - this mode is currently being tested. Imaging polarimetry is only offered in jiggle-map mode in 99A.

Data reduction: A stand-alone package is used for single-pixel reduction. For imaging polarimetry, a reduction script has been developed, and can be used to produce images with polarization vectors overlaid. In late 1998, we expect to update the script for pixel-by-pixel subtraction of instrumental polarization, and also the STARLINK polarimetry package POLPACK may be available in a version compatible with SCUBA data.

Integration times: The SCUBA Integration Time Calculator is currently being updated for polarimetry.

For single-pixel observations use the formula derived here and use an overhead of 100%, plus 1-2 hours per shift for startup, pointing checks etc.

For imaging polarimetry, use the same formula but multiply the times by 4 (for beam-width resolution) or 16 (for half-beam resolution). Then add overhead of 50% plus 1-2 hours per shift as above.

Sensitivity limits: At 850 microns, the minimum detectable POLARIZED flux in photometry mode is ~ 5 mJy (e.g. 1 % polarized, 0.5 Jy source), in 1-2 shifts of observing. Imaging polarimetry limits have not yet been established, but are expected to be a few times higher than for photometry mode - aim for fluxes > 1 Jy at 850 microns! Observations at other wavelengths are generally less sensitive (but NB synchrotron polarization is best observed at 1350 microns, due to the rising flux).

Further information on the polarimeter can be found on the webpage:

http://www.jach.hawaii.edu/JCMT/scuba/scupol/scupol.html

Please address any queries to Jane Greaves
jsg@jach.hawaii.edu

Short Baseline Interferometry

It is anticipated that there will be an opportunity to participate in an SBI run around May 1999. The optimum period in which to arrange this ‘block’ of observations has not yet been decided. Further details on the availability of SBI will be found on the JCMT homepage, and via the e-mail exploder, nearer the event.

Interested applicants are requested to submit their applications by the appropriate deadlines for either JCMT or for CSO. The allocation of a block of time for SBI does depend on scientifically competitive proposals being approved by the time allocation groups for the two telescopes.

South Pole Imaging Fabry-Perot Interferometer (SPIFI)

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

At present, SPIFI has 9 pixels operating. We plan to have the additional 16 pixels installed in September 1998. SPIFI has demonstrated background limited sensitivities in the lab that are equivalent to single side band receiver temperatures of ~ 400 K (5 pixels) and < 800 K (4 pixels) at 370 microns. This receiver temperature is not a function of the velocity resolution employed, and is only a soft function of the line wavelength from 300 to 500 microns. We estimate the best attainable receiver temperatures are ~ 100 K (SSB), and are working towards this goal with reasonable hope of success. At present, SPIFI can tune to any frequency in the 350 micron window, and continuously scan 13 spectral resolution elements at any given wavelength. It is also possible to set up in the 450 micron window. In the near future, we expect to be able to easily switch between the two windows while the instrument is cold. Important astrophysical lines in the 350 micron window include the 371 micron [CI] fine structure line, and the rotational transitions of CO (7-6) (372 micron), HCN (10-9 & 9-8) (338 & 376 microns), and HCO^+(10-9 & 9-8) (336 & 374 microns).

τ(225 GHz) (nepers)	τ(809 GHz) (nepers)	T_{sys} (K)	T_A^*(rms) (K)
0.045	0.70	2060	0.013
0.030	0.40	1500	0.010
0.060	1.00	2800	0.018

Estimated 809 GHz sensitivities of SPIFI per pixel on the JCMT in 1 hour of integration time, scanning 6 spectral resolution elements. For these estimates we have assumed the receptive efficiency of the telescope h_{tel} is 65%.

These sensitivities are calculated based on current lab measurements at a resolving power of 6000 (50 km/s). To scale to other resolving powers, notice that since T_{sys} is independent of the resolving power, T_A^* is proportional to $R^{1/2}$. For example, at a resolving power of 2,000 (150 km/s) T_A^* will be $\sqrt{(2,000/6,000)}$ = 0.58 times smaller (better) than the values in the table.

Note that our sensitivity is not yet optimized. On JCMT it is possible to reach sensitivities 2 or 3 times better than those above, and we are working towards this goal. Current best estimates will be posted on our Web page at the Cornell Astronomy Department Site:

http://astrosun.tn.cornell.edu/research/projects/spifi.html

SPIFI was developed at Cornell University under a NASA grant and is a collaborative venture between individuals at Cornell, Boston University and the SETI institute. It is our hope to achieve first light with SPIFI on the JCMT in early 1999, and our intent to make SPIFI available on loan to the JCMT for the foreseeable future. Our group welcomes scientific collaborations with other JCMT users. Please contact Prof. G. J. Stacey at Cornell University (stacey@astrosun.tn.cornell.edu) to arrange collaborative efforts.

PATT INFORMATION

PATT Application Deadline

Deadlines for receipt of JCMT applications for semester 99A are:

for UK, Canadian, Netherlands and International applications:

30th September 1998

ALL applications have the same deadline for this semester.

Please read the next article - Special Notes for 99A Applicants before filling in your application forms for the forth-coming semester.

To ensure prompt processing, please ensure that your applications are sent to the correct establishment. 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. International applications (those with no applicants from one of the partners) should be submitted to the PATT Secretariat at PPARC, Swindon. Members of the JAC staff in Hawaii count as International unless they are the PI on an application, when it should be forwarded to the appropriate national TAG.

Country paying salary of Principal Investigator		
Canada	**Netherlands**	**UK or International**
Director-General's Office, National Research Council of Canada, 5071 West Saanich Road, Victoria, BC, CANADA V8X 4M6	Dr. J.M. van der Hulst, Kapteyn Astronomical Inst., Postbus 800, NL-9700 AV Groningen, NETHERLANDS	PATT Secretariat, PPARC, Polaris House, Swindon, SN2 1ET, UNITED KINGDOM

Special Notes for 99A Applicants

The deadline for ALL applications for semester 99A (February 1st 1999 through July 31st 1999) is **30th September 1998**.

All applications must arrive at their appropriate collection point by September 30th. These will be processed for the ITAC meeting to be held with the other PATT facilities in early December.

The Latex template application form can be downloaded from the JCMT homepage on the Web. An explanation of how to classify applications into UK, Canadian, Netherlands or International, the correct number of copies required, and the correct addresses of the collecting points can also be found on the Web. Electronic submissions for the Netherlands should be emailed to Groningen. Electronic submissions for Canada should be sent to HIA, Victoria. Electronic submissions for UK and International applications should go to the '**jcmtprop**' account at the JAC.

INSTRUMENTS AVAILABLE

The current status of RxA2, RxB3, RxC2, RxW, SCUBA and the SCUBA polarimeter can be found on the Web. These instruments will be available throughout the semester.

It is anticipated that there will be an SBI run around May 1999. Applications should be sent in as normal by the appropriate JCMT and CSO deadlines. The instruments available will be only RxA2, RxB3 and RxW.

Electronic Submission Update

Canadian and Netherlands Applications

HIA, Victoria and the University of Groningen respectively have the ability to accept electronic submissions. Please refer to local information about formats. Shortly after the PATT deadline all applications are FTP'ed to the JAC and combined with the UK and International applications.

UK and International Applications

1 - to obtain the most recent JCMT application template, send an email to **jcmtprop@jach.hawaii.edu** with the phrase 'request templates' as the Subject. Any subsequent text in the email will be ignored. All necessary files will be emailed back to you.

2 - complete the Latex template as instructed in the header section. There are only minor modifications to this template from the one that you have already been using. These changes are necessary because, at some later date, we intend to automatically parse the returned file to generate the tables and files that the TAGs require.

3 - email the completed Latex template back to 'jcmtprop'. You are also required to submit a Postscript version of your application. Each submission will be acknowledged and several people here will be informed of its arrival.

4 - the system is setup to attempt to spot duplicate entries or revised submissions. If you submit applications with identical PI, collaborators and title they will be treated as the same applications. The latest submission will over-write previous versions.

5 - if you do not wish to play with the electronic system, you may still, for this semester, submit your hard copies through the usual route to PATT Secretariat in Swindon, UK.

PATT ITAC Report for Semester 98B

1. Introduction

This document details the allocations for telescope time made by the ITAC for the semester 98B (1st August 1998 - 31st January 1999).

2. Allocations

The individual partner TAGs hold meetings in their respective countries prior to the PATT session to assess applications deemed by the JCMT Board rule to be from their own country. At these meetings informal numbers of shifts are nominated for each application in a priority order. The Chairpersons of each TAG bring their respective lists to the PATT where the ITAC combine the awards, include discussion of the engineering and commissioning requirements, and assess the International applications. The final allocations of shifts are made by the ITAC.

Applications considered

UK status#	85
Canadian status#	35
Netherlands status	24
International status	23
University of Hawaii	87
TOTAL:	**174**

7 UK starred applications and 3 Canadian carry-overs have been included in this total.

The PATT meeting was held at the Falcon Hotel, Stratford, UK on 2nd & 3rd June 1998.

It should be noted that if the PI on an application is a JCMT staff member based in Hilo, then the application is assessed by the appropriate national TAG. However, by Board rule, International status is given to any application where the only named collaborator from any partner country is a JCMT staff member. International applications are assessed by the ITAC members at their meeting.

Time Available (in 16-hour nights)

No. of nights in semester 98B	183.0
Engineering & Commissioning	5.0
University of Hawaii (10%)	15.5
Director's discretionary use	4.0
Available for PATT science:	**138.5**

The above table indicates the order in which nights are removed from the total available for the semester. The table below indicates the allocations using the JCMT Board formula for attributing applications to countries.

Awards (in 16-hour nights)

UK status	61.9
Canadian status	27.6
Netherlands status	21.6
International status	27.4
University of Hawaii	15.5
TOTAL allocation:	**154.0**

3. Designated Service time

Allocations for this semester are:

CDN = 5.0 shifts allocated;
NL = 0 shifts allocated (with 7 hours set as Nlflex);
UK = 0 shifts allocated (with up to 40 shifts in the UKflex program);
INT = 0 shifts allocated (with 29 hours as INTflex).

4. Non-standard Instrumentation

There were no non-standard instruments allocated time this semester.

Instrument distribution

A-band	11%
B-band	13%
C-band	6%
SBI	5%
SCUBA polarimeter	4%
SCUBA	60%

5. Applications with Long-Term Status

L/M/98B/U30 was given a further 5 shifts in 99A to complete observations of the Galactic Centre region subject to a satisfactory report on progress with the combined semester 98A and 98B observations.

6. Short Baseline Interferometry

There was considerable difficulty in making an acceptable arrangement for an SBI session in semester 98B due to the delay in obtaining information about CSO applications. The deadline for CSO submissions had been set for May 31st which was too close to the ITAC dates to obtain details. However the number of highly-rated PATT applications merited an SBI session and therefore a period of 8 complete nights plus 1 night for E&C setup was set aside for observations.

7. Engineering & Commissioning

A significant period of time has been set aside in October to make seasonal adjustments to the antenna. These adjustments together with thermal data from the antenna should enable a much improved surface rms accuracy.

Time has been allocated for commissioning of RxA3i early in the semester. Some shifts have been set aside for commissioning of the high-frequency component (D-band mixers) of RxW according to the commissioning plans made available by the instrument builders. In addition there is commissioning time for both SCUBA and for its polarimeter.

8. Fallback Programmes

A number of applications have been approved by the ITAC to be included in the schedule should the weather not be appropriate for the primary observations on any night. All applicants (allocated and fallback) have been requested to submit a completed template as soon as possible so their observations can be included on the queue system.

Applicants with starred proposals who have not submitted a complete template by the end of the first month of the semester (31st August) will lose the starred status of the application.

9. The Flex System for the UK

The UK TAG allocated time for only 96.5 shifts of its final allocation of 141 shifts. There is an outstanding 28.5 shifts of starred applications from semester 98A, some of which may be carried over into this semester. Some of these will be completed during semester 98A thus releasing further time for UKflex. The intention is that each high-frequency allocation be extended by typically 50% using UKflex time, thus increasing the chance of obtaining suitable weather to complete the high-frequency program. Under weather conditions unsuitable for the high-frequency observing, the current observers or staff scientist would undertake observations from the UKflex list in serviced mode in priority order. Successful applicants on the UKflex list have been informed that they have to submit complete templates for their observations but that there is no guarantee that any part of their program will be done during the semester.

10. The Flex System for Other Partners

A flexible system is already in operation by the Netherlands community. The Canadian community intend to begin a flexibly queued scheme starting with semester 99A.

11. Queue-based Flexible Implementation

All applications for semester 98B were nominated weather grades by the national TAGs prior to the ITAC meeting. These weather bands will be used to determine whether the primary project will continue or whether a fallback application will be implemented.

12. Electronic Submission

The expansion of the trial scheme to include the UK community was extremely successful. Within 48 hours of the deadline almost all applications (Canadian and Netherlands sets were ftp-ed across and inserted) were on-line at the JAC with 2 hardcopies produced. Only a few (less than 6) applications were posted as hardcopy to Swindon, most of which were later obtained in electronic postscript. The JCMT application template (PATT3) has been modified for use by ALL applicants so that all partners have a similar postscript format.

13. Modifications to the UK (and International) Service Application Procedures

The UK TAG made some changes to the submission and assessment procedures for the UK and International service applications. The details were contained in an announcement circulated to the community in late July. It is contained elsewhere in this Newsletter.

11. Procedures for Semester 99A

The deadline for for semester 99A (1st February 1999 through 31st July 1999) applications is 30th September 1998 for ALL applicants. This deadline encompasses applications for all available instrumentation on the JCMT (RxA2, RxB3, RxW, SCUBA, and the SCUBA polarimeter). There is also likely to be an SBI run during the semester.

STATISTICS

Weather and Fault Statistics

The following tables present the weather loss and fault loss for semester 98A. A detailed description of how these tables are created was available in the previous Newsletter.

Month	Avail Hours	Extend Hours	Primary Loss	%	Backup Loss	%
February	424.0	58.5	21.0	5.0	15.5	3.7
March	496.0	29.8	12.7	2.6	10.5	2.1
April	480.0	40.3	21.0	4.4	18.5	3.9
May	495.5	22.8	59.3	12.0	19.3	3.9
June	480.0	10.0	67.5	14.1	12.5	2.6
July	496.0	11.3	66.3	13.4	40.3	8.1
Total	**2871.5**	**172.7**	**247.8**	**8.6**	**116.6**	**4.0**

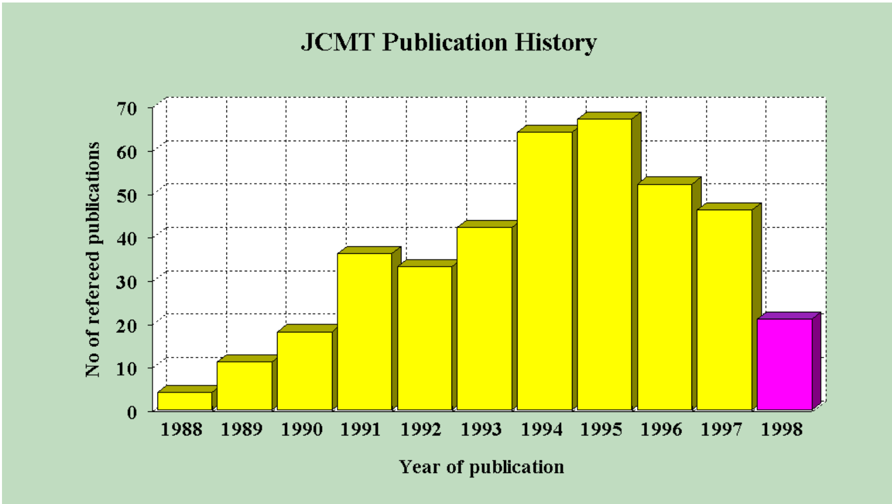
Table 1: *JCMT weather statistics.*

Month	Avail	Total	ANT	INS	COMP	SOFT	CAR	OTH
February	424.0	19.1	2.2	9.4	1.7	4.7	1.1	0.0
March	496.0	18.6	9.8	0.9	4.4	3.3	0.0	0.3
April	480.0	8.3	0.1	3.3	0.5	4.3	0.1	0.0
May	495.5	11.6	3.5	3.8	0.5	0.3	0.0	3.5
June	480.0	53.0	2.5	39.4	3.0	7.1	0.0	1.0
July	496.0	16.1	0.3	5.5	5.3	4.9	0.3	0.0
P(hours)	2871.5	126.7	18.4	62.3	15.4	24.6	1.5	4.8
B(hours)		3.5	0.0	0.7	0.0	1.3	0.0	1.5

Table 2: *JCMT fault statistics. Wherever possible the faults are categorised into ANT = antenna; INS = instrument; COMP = computer hardware; SOFT = software; CAR = carousel; with the remainder going to OTH = other. The figures in the table may not appear to add up correctly due to rounding in the original program. P defines the time lost from Primary projects. The category B(hours) is the time lost to Backup projects.*

Publication Statistics

It is **YOUR** responsibility to ensure that the relevant JCMT staff (Henry Matthews, Jane Greaves and/or Graeme Watt) either have a copy of each of your publications containing JCMT data or, at least, have a reference to include in the tables. We do try to scan the journals but this method is not foolproof and there is no more efficient method than to have the authors contact us.



A frequently updated list of known JCMT refereed papers published during 1998 can be found on the JCMT homepage. These data go into the Annual Reports so it is important that the total reflects the true number of refereed publications each year.

TECHNICAL NOTES

The JAC Safety Manual

The Joint Astronomy Centre now has an official Safety Policy statement and a copy of the JAC Health and Safety Manual is available on the Web for anyone to access at URL of http://www.jach.hawaii.edu/safeman/frontm.htm

The Safety Policy statement is now strictly adhered to and the Health and Safety Manual is kept under constant revision and update by the JAC Safety Committee.

All staff, visitors and observers to the JAC, JCMT or UKIRT should be aware of the Safety Policy and the relevant sections of the Health and Safety Manual pertaining to the conditions of their visit. Visitors and observers will always have a member of staff responsible for keeping them informed of safety issues during their stay at the JAC, JCMT or UKIRT.

The 1997 JCMT Annual Report

The JCMT Annual Report for 1997 has been printed and will shortly be in the post to those who are already on the mailing list.

Most of the current issues go to Libraries and Departments. However, if you wish to have your own hardcopy version of this report, previous ones, and/or those for future years then please send your name and address to Graeme Watt.

Downloadable versions of the 1997 JCMT Annual Report can be found in Postscript format or in Adobe Acrobat format from the Newsletter web page.

Of course, the 1998 Annual Report is already under construction and the Editor will be contacting people for contributions in due course.

An Early Start to Evening Shifts

Studies over the past few months show that changing ambient temperature effects on the antenna surface during the early evening can be significantly reduced if the carousel is opened well in advance of the commencement of observing. A closed building tends to exaggerate the distortions to the surface and when the building is finally opened. These effects persist well into evening shift, making it necessary for more frequent pointing, focus and efficiency checks.

Therefore, wherever possible, the TSS will open the building early to allow the antenna to stabilise well in advance of the nominal 17:30 start of evening shift. However, the daycrew leave the telescope at 16:00 sharp and if nobody is remaining to buddy the TSS then the TSS must also leave. This means that the building will be closed and the software systems run down.

If would be extremely helpful, to both the TSS and to the observers, if the evening shift observers at HP telephoned the TSS at no later than 15:30 to discuss the weather conditions, the state of the instruments and thus make preliminary plans for their evening shift.

Observers can, if they want to get a good start, drive to the telescope prior to the daycrew leaving at 16:00. The TSS will be able to leave the carousel open and make most, if not all, of the startup checks and tests (including the first run through pointing, focus and calibration) well in advance of the 17:30 nominal shift start time.

If observers are not particularly worried about an early start then at least the TSS is aware of this and can come down to HP for dinner without having to immediately turn around and drive back up with observers. Or, as is often the case, the TSS meets the observers on the way down to HP and has to turn around and go up again, having just completely shut down the carousel and the observing system.

Service Mode Acknowledgements

Now that the JCMT is running a significant number of projects in a serviced mode the question of how to appropriately acknowledge the observers has arisen.

In many cases, fallback programs are done entirely by visiting observers, JCMT staff scientists, or (on occasion and becoming more frequent) by the TSS on duty. It is often the case that projects with formal allocations are also completed in serviced mode.
Actually taking the data is a significant part of any observing application and being able to ensure that the data collected is of high-quality, taken under appropriate circumstances is a skilled task that should not go unrecognised.

In addition to the general acknowledgement that should be attached to each published paper containing JCMT observations, it would seem courteous for PIs to consider including the names of the ‘major’ observers of their program. The decision of how to choose the ‘major’ contributors to the data collection is left to the PI.

Modifications to the UK (and International) Service Observing Application Procedures

Introduction

At their May 1998 meeting the UK-TAG held a lengthy discussion about the structure and the future of the UK Service observing programme. They have decided that the programme is still an extremely useful tool for the UK community to obtain timely (target-of-opportunity) observations, to complete previous PATT proposals that were weathered out or lost time due to observatory problems, and to make pilot studies in preparation for submitting full-blown PATT applications.

The TAG were not averse to continuing the practice of allowing the International community to submit service applications through this channel. International service applictions would still be included in the UK Service program as before.

However, the TAG did agree that the current system of submission, assessment and allocation was unwieldy and required modifications to bring it into line with the new JCMT electronic submission system, and to make the process much simpler to operate and manage.

Therefore the changes below are to be implemented with immediate effect for Service applications requesting time during Semester 98B.

Applying for Time

Applicants requesting observing time should now proceed along the same lines as those making full-blown PATT applications. The current version of the JCMT application template can be obtained by sending an email to the 'jcmtprop' account at the JAC (email to: jcmtprop@jach.hawaii.edu) with the phrase 'request templates' in the Subject line of the email. Any text following the header message will be ignored by the parser.

The template to be completed is identical to the regular PATT3. All information for the service application must be completed as for a regular PATT application. Please note that the SCIENTIFIC JUSTIFICATION for a service application must be limited to half of a single page. Figures, tables, diagrams and technical details may be included on an additional page as usual.

Submission Categories

The completed service application can be submitted back to 'jcmtprop' at any time. Since the parser only looks at the 'Subject' heading of the email to determine whether the application is a new or a revised proposal all applicants must ensure their proposal is sent with the appropriate heading in the 'Subject' of the email.

*If this is a new UK/International Service proposal the Subject line has to be:

new service uk

or

new service int

The parser will assign a slightly modifed PATT number to each proposal which will be sent to you via return email. This number is of the usual form preceded with an 's' instead of the 'm' to indicate service proposal, for example, s98bu006 or s98bi004 etc.

*If this is a revised service proposal the Subject line has to be:

revised proposal s98bu006

b) if this is a re-submission of an earlier rejected PATT application then please reference that application in the text so the TAG can refer to earlier notes.

There are, of course, no deadlines for submission of service applications. They may be submitted to 'jcmtprop' at any time during the semester and they will be processed as rapidly as possible.

Reminder about Full-Length PATT Applications

*If this is a new full-length PATT proposal the Subject line has to be:

new submission xx

(where 'xx' is uk, cn, nl, or int)

The parser will assign a PATT number to each proposal which will be sent to you via return email. This number is of the usual form, for example, m98bu006, m98bc020, m98bn102 or m98bi011 etc.

*If this is a revised full-length PATT proposal the Subject line has to be:

revised proposal m98bu006

(or whatever number)

NOTE: putting an incorrect heading in the 'Subject' of your email submission may result in delays with processing your application.

Instruments/Time Limits

The service programme is now open to ALL instruments that the JCMT has advertised as available for that semester. Therefore for Semester 98B applicants may apply to use RxA2, RxB3, RxC2 (or the C-band section of RxW), the heterodyne polarimeter (on either RxA2 or RxB3), SCUBA, and the SCUBA polarimeter. Applications requesting the D-band section of RxW should await an announcement that it is operational on the telescope.

Applications requesting time using the heterodyne or continuum instrumentation should be restricted to total integration times (including overheads) which depend on the requested weather band.

- for grade 1/2 weather the maximum limit is 2 hours;
- for grade 3 weather the maximum limit is 4 hours;
- for grade 4/5 weather the maximum limit is 8 hours (1 full shift).

The Processing

Each service application submitted will be automatically numbered by the parser and you should receive acknowledgement within a day or so. The application will be sent to 2 members of the UK-TAG for assessment and refereeing. If the application is approved the TAG will nominate a position for the application within one of the already existing queues and the proposal will be inserted at that point.

Please note there is no longer a separate UK Service queue. All successful applications will be inserted at an appropriate position within the existing queue structure. For the technically minded, this now means that the service applications will come out of the UKflex allocations.

Applicants will be informed as soon as possible whether their proposal has met with success and where it has been inserted in which weather queue. It is then of utmost importance that applicants submit a completed template for these observations as soon as possible so that the data can be taken whenever convenient.

The Observations

Normally these observations will not be of sufficient length to merit observers travelling to Hawaii and will usually be including for flexible scheduling, therefore observing will be conducted by JCMT staff scientists.

The Data

Applicants will be informed as soon as possible after some of the data has been taken. If appropriate the PI will be contacted prior to or during the observations. The completed dataset can be obtained via the usual route.

Graeme Watt
(ITAC Technical Secretary)
30th July 1998

SCUBA Chop Tracking Bug

SMU chop update bug in jiggle mapping/photometry

On 27th July, we discovered a bug in the SCUBA observing software related to (Ra,Dec), or LO, chopping. The correct behaviour is that the components of the chop in the SMU (az,el) co-ordinate frame (shown on the status screen as NSamp and EWamp) should slowly but continuously update as the parallactic angle rotates on the sky. Unfortunately, the commands to perform this "chop tracking" had been left out of the SCUBA observing scripts. This means that at the beginning of each new observation, the chopper would be started with the updated (az,el) components corresponding to the requested (Ra,Dec) chop throw, but these would then remain fixed during the observation.

This bug will have affected all observing modes apart from raster mapping (which is performed by a different, correct script). In particular jiggle mapping and photometry performed with LO chop throws will have suffered from this bug. Two-bolometer chopping will also have been affected. The problem was identified and cured on 28th July 1998.

This problem does NOT affect programmes where azimuth chopping was employed; the major programmes affected will be the deep surveys where long integrations (~1 hour at a time) and small LO chops (in-field chopping using 30-45 arcsec throws) were adopted. Some galactic programmes may have also been affected for which LO chopping was used to avoid off-beam signal contamination. Although larger chop throws (*e.g.* 120 arcsec) were generally employed in these cases, the integration times would have usually been shorter, reducing the severity of the effect (see below).

However, we hope that this bug will not have had a major impact on existing data. The effect will basically have been to smear the off-beam in an arc from the correct position. Assuming a reasonably large region of blank sky had been chosen for the off position, the only effect should be that a ‘different’ piece of blank sky would have been used. Obviously if a source was in a confused region, and long individual integrations were performed, there is a possibility that the off-beam may have moved across a region of emission. Again, this will only have been a significant effect if sources were observed, with long individual observations, near transit.

The magnitude of the effect depends upon the declination of the source and the hour angle of the observation. For sources above dec = 60, or below dec = -20, the rate of rotation varies from ~10 - 20 deg/hour. For sources which transit at higher elevations, the rate of rotation starts off lower, but increases rapidly as the source transits. Formulae for calculating the rate of rotation are available from the JCMT on request.

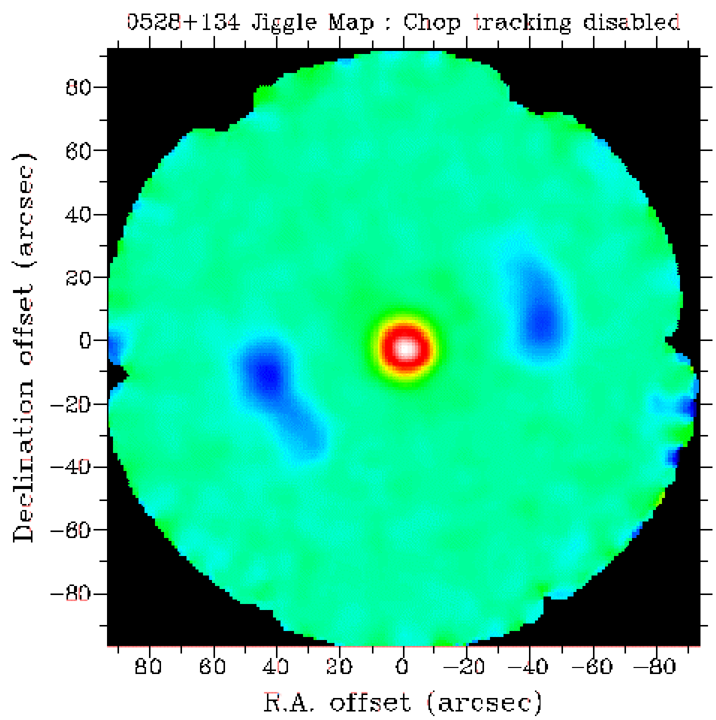


Figure 1.

In order to demonstrate the magnitude of the effect, and ensure that the fixed observing scripts were working correctly, test observations were carried out using the bright blazar 0528+134. The blazar was observed before transit for 45 mins with chop tracking disabled, and similarly immediately after transit with the new, corrected scripts. Figure 1 shows the case when chop tracking was disabled, and the two off-beams are seen to smear out into an arc around the central source. Figure 2 is the observation of the same same with chop tracking enabled after transit – the off-beams are now well-defined. This example is also somewhat of a "worse-case scenario" since the source declination of +13 degrees means that the rate of rotation of the parallactic angle is quite extreme near transit.

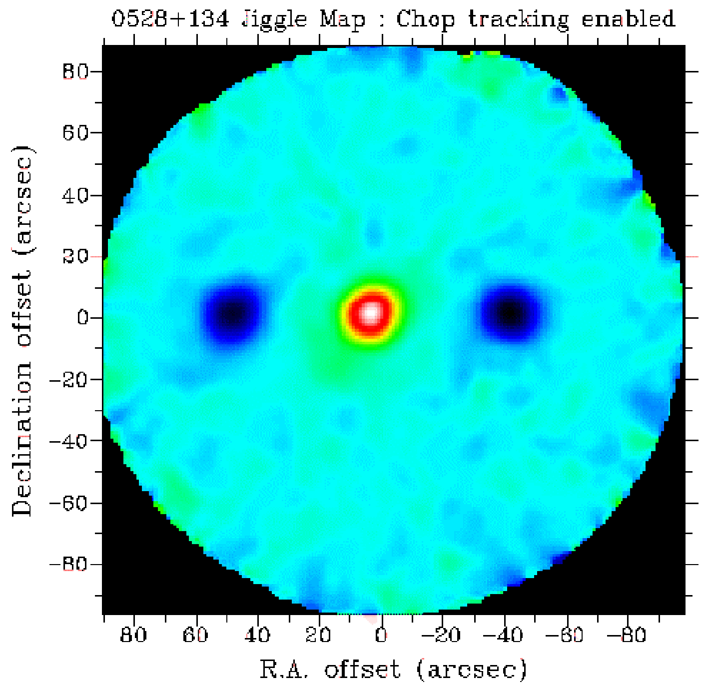


Figure 2.

Please feel free to contact Richard Prestage or Wayne Holland at the JCMT if you need any further information.

Richard Prestage, Firmin Oliveira, John Lightfoot, Wayne Holland
31st July 1998

SCIENCE HIGHLIGHTS

These articles are taken from Press Releases on the web and in most cases lose something in the transformation. Use the web link from the JCMT Newsletter to the full version of the stories which contain much more detail in a more effective presentation.

SCUBA discovers a Distant Galaxy hidden in Dust

A team of scientists from Italy and The Netherlands has discovered a distant, optically almost invisible galaxy in which hundreds of new stars are being formed every year. The astronomers Andrea Cimatti (Astrophysical Observatory of Arcetri, Firenze), Huub Röttgering (Sterrewacht Leiden), Paola Andreani (University of Padova, Padova), and Remo Tilanus (NFRA, Dwingeloo and Joint Astronomy Centre, Hawaii) announced their discovery in the April 30th issue of the internationally renowned journal Nature.

The galaxy, HR10, is placed at a redshift of 1.4 which means that its light has been underway so long that the image we observe is that of the galaxy from a time when the universe was less than half its present age. The astronomers selected this galaxy for observations, because HR10 is the best known example of a class of very faint galaxies with extremely red colours. Andrea Cimatti says: "These galaxies are so red that their faint optical emission can only be detected after very long exposure times with the largest telescopes in the world. In recent years increasingly more of these mysterious galaxies have been detected and the question arose why they are so red."

Huub Röttgering adds: "On Earth we see that blue light is strongly being absorbed by dust, but that red light can pass through a dusty cloud relatively unhindered. Until now, an unproven hypothesis was that the stars of these red galaxies are deeply embedded in dust clouds. These clouds severely redden the observed colours of the stars and hence the galaxies.

The team of astronomers used the fact that dust is being heated by starlight and as a result of this radiates at wavelengths around a millimetre. For comparison, optical light has a wavelength of less than 1/1000th of a millimetre. Sub-millimetre radiation can be observed and measured by the 15 metre diameter James Clerk Maxwell Telescope (JCMT) atop the dormant volcano Mauna Kea in Hawaii. The JCMT is jointly owned and operated by the United Kingdom, Canada, and The Netherlands and is the largest telescope which can observe sub-millimetre radiation. Recently this telescope has been outfitted with a new camera called SCUBA (Submillimetre Common User Bolometer Array), which was built by the Royal Observatory in Edinburgh. The detectors in SCUBA are cooled to a tenth of a degree above absolute zero which makes it possible to obtain extremely sensitive images.

Remo Tilanus reports: "When we pointed the telescope and SCUBA at HR10 we found that this extremely faint optical galaxy emits very strongly at submillimetre wavelengths. This strong emission indicates that in the galaxy a large amount of dust is being heated by embedded hot and young stars." In addition, HR10 was also detected with the IRAM 30-m telescope in Spain which makes observations in the millimetre wavelength range.

Paola Andreani adds: "The reliability of our results on the presence of the large amount of dust obscuring the optical light is based on the combination of two different measurements, taken with different instruments. Note that only the association of the two measurements at different wavelengths allowed us to estimate the temperature of the dust."

According to Röttgering this is an exciting discovery because for the dust particles to be emitting so much radiation there must be a lot of young stars in the galaxy. The astronomers have calculated that in HR10 hundreds of new stars must form every year in order to account for the observed emission. At that rate HR10 produces tens of times more stars than our own Galaxy! As the galaxy ages, the rate of star formation must decline: the amount of dust and gas, the building blocks for new stars is being exhausted. Röttgering adds: "In HR10 we not only see the formation of new stars, but also how a massive galaxy could form".

Cimatti explains: "Our result has two main implications. First of all, it sheds new light on the enigmatic population of optically faint and extremely red galaxies, suggesting that at least a fraction of them are very dusty star-forming young galaxies. Secondly, our results show that the history of the global star formation in the Universe cannot be derived from optical observations only. The star formation rate of HR10 derived from optical observations only is at least a hundred times lower than that suggested by our sub-millimetre observations, and this occurs because of the large amount of dust which obscures the light coming from the star-forming regions."

"Our observations suggest that a, possibly substantial, fraction of the global star formation in the distant Universe could be hidden by dust obscuration and that sub-millimetre observations are crucial to unveil the population of dusty galaxies where vigorous star formation occurs. Only with telescopes like the JCMT and with new instruments like the SCUBA camera is it possible to study these red objects in more detail. This is important: most theories about the formation of galaxies do not take this class of objects into account yet. Future observations will indicate how important objects like HR10 are for our ideas about the evolution of galaxies and the creation of the Universe as we presently see."

Possible new Solar System in formation around nearby stars Vega and Fomalhaut

Astronomers at the Joint Astronomy Centre (JAC) in Hawaii and at the University of California (UCLA) in Los Angeles today report that they have obtained the first pictures of huge disk-like structures of dust around two of the brightest stars in the sky - Vega and Fomalhaut. These images may reveal planetary systems in formation, and suggest that planets in our galaxy may be more common than scientists previously believed.

The team of British and American astronomers report their findings, based on their observations of three well-known stars in our Milky Way Galaxy - Vega, Fomalhaut and Beta Pictoris - in the April 23rd issue of the journal Nature.

"One of the most striking features we see is a central hole in the disk around Fomalhaut," said Wayne Holland, who led the astronomy team at the JAC. "The lack of bright emission close to the star suggests that dust is largely cleared out, and a probable explanation is that it has formed into rocky planets like the Earth, even though we cannot detect these directly".

"It is generally believed that our own Solar System formed out of such a disk" said Benjamin Zuckerman, UCLA professor of Physics and Astronomy, "but whether the newly discovered disks contain majestic planets like Jupiter and Saturn, or just comets and asteroids, remains to be seen".

What can these stars tell us about our own Solar System?

The ages of Vega, Fomalhaut and Beta Pictoris - from tens to hundreds of millions of years - span a range of great importance in the history of our own Solar System, the astronomers noted. Our Sun's estimated age is around 4.5 billion years, and the giant planets, Jupiter and Saturn, are believed to have formed 10 million years after the Sun, whilst the Earth took something like 100 million years to form.

For about 600 million years, our Solar System was bombarded by comets and asteroids, until, as Zuckerman said, "the gravitation of Jupiter and Saturn, the 'garbage men of the solar system', cleaned out these massive objects that could have decimated life".

These star systems may teach us much about the history of our own Solar System. "What we see is almost exactly what astronomers orbiting nearby stars would have seen if they had pointed a millimetre-wavelength telescope at our own Sun a few billion years ago" said Jane Greaves, one of Holland's colleagues at the JAC.

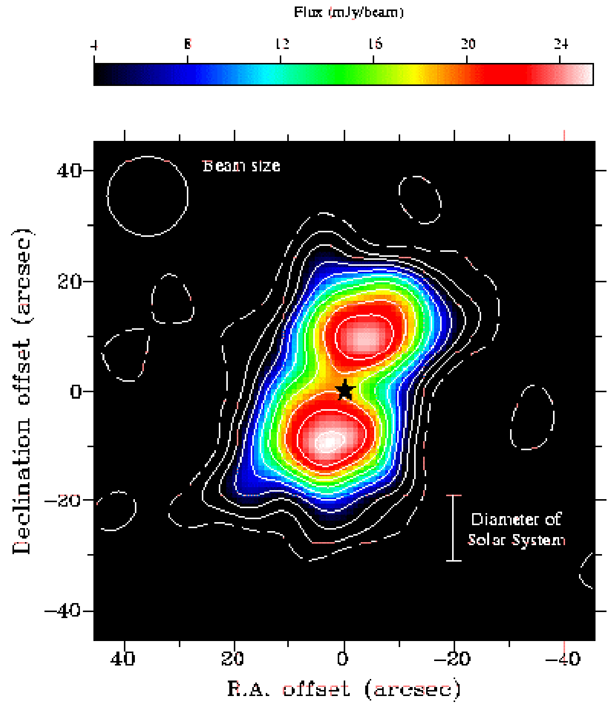
How were the new images obtained?

The new images - which are not optical pictures, but rather radio images produced through "submillimetre astronomy" - were obtained using the 15-metre James Clerk Maxwell Telescope at the Mauna Kea Observatory in Hawaii. The JCMT is the world's largest telescope dedicated to the study of light at "submillimetre" wavelengths. The team of astronomers used a revolutionary new camera called SCUBA (Submillimetre Common User Bolometer Array), which was built by the Royal Observatory in Edinburgh.

"SCUBA uses detectors cooled to a tenth of a degree above absolute zero (-273 degrees Celsius) to measure the tiny amounts heat emission from small dust particles at a wavelength close to one-millimetre", said Holland.

The astronomers reported on the following:

Fomalhaut, the brightest star in the constellation Piscis Austrinus (the Southern Fish), is believed to be about 200 million years old - very young compared to our Sun. In the new image the brightest emission, and therefore the most dust, is surprisingly far from the star. The star appears to be surrounded by a huge disk of dust aligned roughly in a north-south direction with a hollow central cavity.



Fomalhaut

Why has the dust disappeared from the star's inner region? The most exciting explanation is that the dust has coalesced and formed into planets. Other possibilities include that the dust was absorbed into Fomalhaut or blown away from the star.

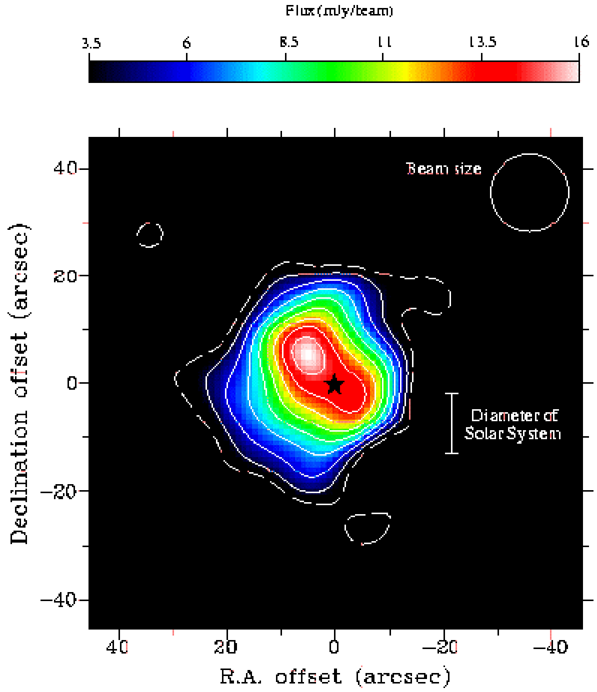
The image appears like a doughnut, with a hole in the center comparable to the size of our own planetary system. The region with the brightest emission is located a distance from Fomalhaut that matches what is called the "Kuiper belt of comets" out beyond Neptune and Pluto in our own system.

"We could be seeing a region around Fomalhaut that is rich with countless comets, although the images cannot reveal comets directly", Holland said.

Mystery at Vega, the brightest star in the summer sky

Vega, in the constellation of Lyra (the Lyre) and the brightest star in our summer sky, is the oldest star of the three at 350 million years old. Viewers of the movie "Contact" will also remember that Vega was the source of radio transmissions received by astronomer Ellie Arrowway (Jodie Foster), who was ultimately transported to Vega to communicate with extraterrestials.

The new SCUBA image of Vega shows it to be enshrouded in faintly glowing dust. As with Fomalhaut, the brightest peak is not centered on the star but at a distance from Vega of about seven thousand million miles - about twice the distance from our own Sun to Pluto. However, this time the emission is concentrated in only one peak which puzzled the astronomers.



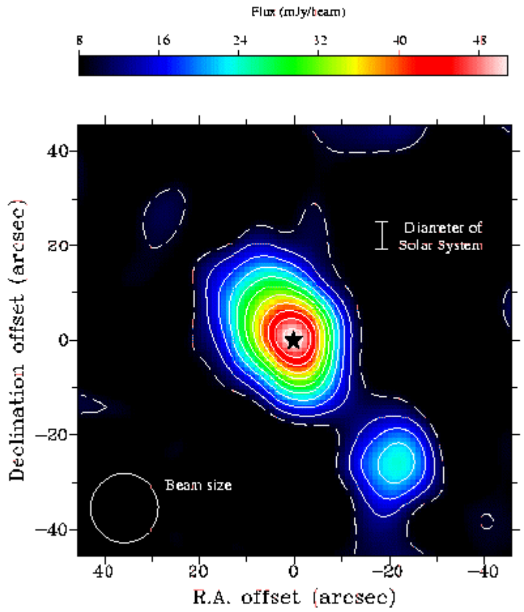
Vega

The astronomers made a deep search with the 10-metre Keck Telescope (also on Mauna Kea) - the world's largest optical and infrared telescope - for infrared light from possible planets or "brown dwarfs". They detected no such objects, and have no explanation for this bright "blob".

"This bright blob is a real mystery - we simply don't have an explanation yet" Zuckerman confessed. "If it is indeed associated with Vega, it's completely unknown. We can suggest explanations - such as a dust cloud around a giant planet orbiting Vega - but they are complete guesses at this point".

Beta Pictoris, in the southern constellation of Pictor (the Painter's Easel) is the only one of the three stars that had been previously imaged. It is also one of the youngest stars in our Solar neighbourhood - being only about 30 million years old. The emission from dust in this case seems to be mainly concentrated at the position of the star, but as with Vega, there is also an unidentified blob in line with the disk.

This source may be a disconnected fragment of the disk in orbit around an unseen companion planet, the astronomers said. It is far from Beta Pictoris - some 10-20 times the distance from our Sun to Pluto. While the blobs in the Vega and Beta Pictoris images may be dust-enshrouded giant planets, planets are not supposed to be able to form at such great distances from stars, the researchers noted.



Beta Pictoris

"In the Beta Pictoris picture, if this blob is indeed associated with the star," Zuckerman said, "presumably it's a planet-like object surrounded by dust - which is completely unexpected, a total mystery. The blobs in the Vega and Beta Pictoris images seem to be telling us something very surprising, and we have more questions than answers at the moment".

Are planets common?

"These are stars that everyone sees when they look up at the night sky. Fomalhaut looks quite similar to the way we think our own Solar System looked when it was 200 million years old," Zuckerman said, "but the other two stars are very baffling."

Noting that none of the stars has retained a large enough mass of dust to form planets, the astronomers say that if these stars are orbited by planets, they have most likely already formed, or are well on their way to forming.

"If the blobs around Vega and Beta Pictoris surround planets, that could tell us that planets are a common phenomenon", Holland said.

"Even if planets are more common than was believed, these findings do not make intelligent life in the universe more likely", Zuckerman said.

Ian Robson, Director of the JCMT, said "SCUBA really is a fantastic new instrument. This is just one of the exciting new discoveries that SCUBA is making that is revolutionising submillimetre astronomy and our knowledge of the Universe".

Holland's team also included astronomers Jane Greaves, Iain Coulson, Dolores Walther, William Dent, Walter Gear and Ian Robson, and Zuckerman's included UCLA graduate students Richard Webb and Chris McCarthy.

JCMT discovers a Nearby Star System just like our own Solar System

An international team of astronomers from the Joint Astronomy Centre (JAC) in Hawaii, the University of California at Los Angeles (UCLA) and the Royal Observatory in Edinburgh announced today the discovery of a ring of dust particles around a nearby star, Epsilon Eridani, that appears to signify a Solar System very similar to our own.

The ring is "strikingly similar" to the outer comet zone in our Solar System, and shows an intriguing bright region that may be particles trapped around a young planet, said JAC astronomer Jane Greaves, who led the research team.

"What we see looks just like the comet belt on the outskirts of our Solar System, only younger," said Greaves, who presented the findings today at the "Protostars and Planets" Conference in Santa Barbara. "It's the first time we've seen anything like this around a star similar to our Sun. In addition, we were amazed to see a bright spot in the ring, which may be dust trapped in orbit around a planet."

Why is Epsilon Eridani so interesting?

Greaves was a member of the international team that reported new images of dusty disks around the hotter stars Fomalhaut and Vega in April (Dusty Disks). However, the new image of Epsilon Eridani is even more exciting for several reasons:

"Epsilon Eridani is far more similar to our Sun than either Vega or Fomalhaut." she said. "This star system is a strong candidate for planets, but if there are planets, it's unlikely there could be life yet. When the Earth was this young, it was still being very heavily bombarded by comets and other debris."

"It is also a star in our local neighbourhood, being only about 10 light years away, which is why we can see so much detail in the new image"

Epsilon Eridani is clearly visible to the naked eye, in the constellation Eridanus (the River), which stretches from the foot of Orion (near the bright star Rigel) to the 9th brightest star in the sky, the southerly Achernar (barely visible from the USA and Europe). Epsilon Eridani is among the 10 closest star systems to the Earth.

"If an astronomer could have seen what our Solar System looked like four billion years ago, it would have been very much as Epsilon Eridani looks today," said Benjamin Zuckerman, UCLA professor of physics and astronomy. "This is a star system very like our own, and the first time anyone has found something that truly resembles our Solar System; it's one thing to suspect that it exists, but another to actually see it, and this is the first observational evidence."

The research team -- which also includes astronomers from the University of Arizona, University College London, and the Rutherford Appleton Laboratory -- has submitted its findings to the Astrophysical Journal Letters, the most widely-read scholarly journal in astronomy.

More about the discovery:

Beyond Pluto in our Solar System is a region containing more than 70,000 large comets, and hundreds of millions of smaller ones, called the "Kuiper belt". The image obtained by Greaves' team shows dust particles that the astronomers believe are analogous to our Kuiper belt at the same distance from Epsilon Eridani as the Kuiper belt is from our Sun. Although the image cannot reveal comets directly, the dust that is revealed is believed to be debris from comets, Greaves said.

Epsilon Eridani's inner region contains about 1,000 times more dust than our Solar System's inner region, which may mean it has about 1,000 times more comets, the astronomers said. Epsilon Eridani is believed to be only 500 million years to 1 billion years old; our Sun is estimated to be 4.5 billion years old, and its inner region is believed to have looked very similar at that age.

In our Solar System, the first 600 million years was a time of "heavy bombardment" when the planets were assaulted by massive meteorites and other celestial objects until the gravitation of Jupiter and Saturn cleaned out these destructive objects. Life on Earth probably did not start until after the era of heavy bombardment, said JAC astronomer Wayne Holland.

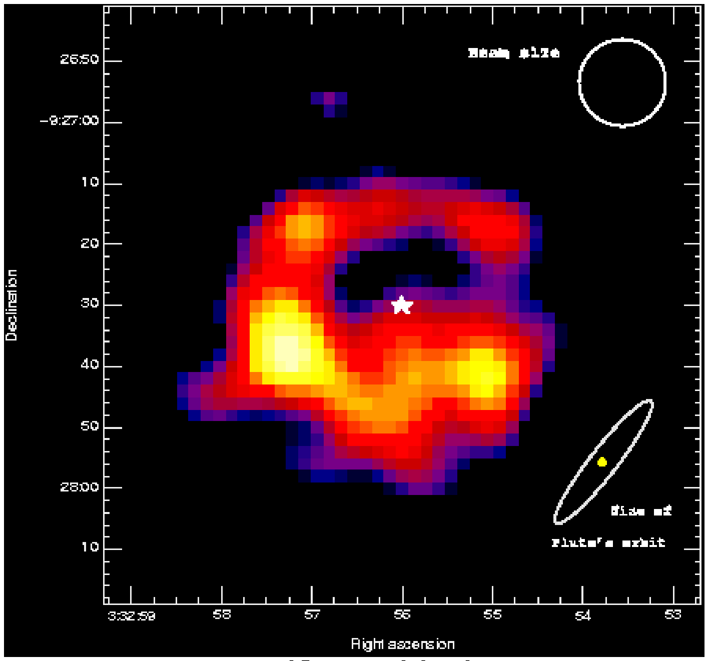
How was the new image obtained?

The new image -- which is from short-radio wavelengths, and is not an optical picture -- was obtained using the 15-meter James Clerk Maxwell Telescope at the Mauna Kea Observatory in Hilo, Hawaii. The JCMT is the world's largest telescope dedicated to the study of light at "submillimeter" wavelengths. The team of astronomers used a revolutionary new camera called SCUBA (Submillimeter Common User Bolometer Array), which was built by the Royal Observatory in Edinburgh (which is now the UK Astronomical Technology Centre). SCUBA uses detectors cooled to a tenth of a degree above absolute zero (-273 degrees Celsius) to measure the tiny amounts of heat emission from small dust particles at a wavelength close to one-millimeter.

Implications and mysteries of the new discovery

What is the significance of the similarity between Epsilon Eridani and our own Solar System?

"The implication is that if there is one system similar to ours at such a close star, presumably there are many others," Zuckerman said. "In the search for life elsewhere in the universe, we have never known where to look before. Now, we are closing in on the right candidates in the search for life."



Epsilon Eridani

Epsilon Eridani is probably too young to support even primitive life, the astronomers said, but there may be other similar star systems that are billions of years older, and are good candidates to search for life. Although astronomers have not yet located a star system that is the right age with the right atmosphere to support life, they are getting closer.

A region near the star that is partially evacuated indicates that planets may have formed, the astronomers said; the presence of planets is the most likely explanation for the absence of dust in this region because planets absorb the dust when they form.

What is the bizarre bright spot in the image obtained by the astronomers?

"There may be a planet stirring up the dust in the ring and causing the bright spot," said Bill Dent of the Royal Observatory, Edinburgh, "or it could be the remnants of a massive collision between comets."

Epsilon Eridani is about three-quarters as massive as the sun, but only one-third as luminous. When astronomer Frank Drake conducted the first serious search for radio signals from other civilizations in the late 1950s, Epsilon Eridani was one of the first two stars he studied. Today, researchers know something Drake did not: Epsilon Eridani is much too young to have intelligent life. However, the new image shows there may be at least one planet, and perhaps life in the future.

In addition to Greaves, Holland, Zuckerman and Dent, the astronomers on the project are Gerald Moriarty-Schieven and Tim Jenness at JAC; Harold Butner at the University of Arizona, Tucson; Walter Gear at University College London; Helen Walker at the Rutherford Appleton Laboratory; and UCLA graduate students Richard Webb and Chris McCarthy.

SCUBA Observations reveal Distant Star-forming Galaxies obscured by Dust

THE HIDDEN UNIVERSE REVEALED: THE DISCOVERY OF A NEW POPULATION OF DISTANT STAR FORMING GALAXIES OBSCURED BY DUST

A team of American and Japanese astronomers has detected a population of distant, dusty galaxies which are radiating roughly the same amount of stellar energy as the entire optical Universe. The astronomers Amy Barger, Lennox Cowie, David Sanders, Eliza Fulton (University of Hawaii), Yoshi Taniguchi (Tohoku University, Japan), Yasu Sato, Haruyuki Okuda (Institute of Space and Astronautical Science, Japan), and Kimiaki Kawara (University of Tokyo, Japan) announced their discovery in the July 16 issue of the internationally renowned journal Nature. A parallel study of a smaller area around the well known Hubble Deep Field performed by a British group led by David Hughes (University of Edinburgh) appears in the same issue of Nature and reaches broadly similar conclusions.

These results are important because they suggest that much of the star formation occurring in the distant Universe may be hidden to visual observations from ground-based observatories and the Hubble Space Telescope.

“The recent submillimeter observations have opened an exciting new era in cosmological exploration comparable to that which occurred with the restoration of image quality with the Hubble Space Telescope,” said Richard Ellis, Director of the Institute of Astronomy at the University of Cambridge in the UK. “The pioneering deep exposures conducted by groups in Hawaii, the UK, and Canada have shown the importance of studying galaxies at large look-back times at wavelengths other than simply the traditional optical and infrared regions. Understanding this new population is essential in order to obtain a comprehensive picture of cosmic galaxy formation.”

Dust in galaxies absorbs starlight emitted at visible wavelengths by hot young stars and reradiates it at much longer wavelengths. In very dusty galaxies most of the light emitted by stars in the visible may be reradiated into the far-infrared. For galaxies at large distances this light is further “redshifted” by the expansion of the Universe to wavelengths slightly less than a millimeter. For comparison, the wavelength of visible light is about 1000 times shorter than one millimeter. Thus, dust-enshrouded galaxies that may be obscured or even invisible in the optical can be detected in the submillimeter.

The astronomers performed a deep survey of two blank regions of sky using a revolutionary new instrument on the 15-meter diameter James Clerk Maxwell Telescope (JCMT) atop the dormant volcano Mauna Kea on the Big Island of Hawaii. The JCMT is jointly owned and operated by the United Kingdom, Canada, and the Netherlands and is the largest telescope in the world that can observe submillimeter radiation. The instrument is a camera called SCUBA (Submillimeter Common User Bolometer Array), built by the Royal Observatory in Edinburgh (now the UK Astronomical Technology Centre). The supercooled detectors used in SCUBA measure heat emission from small dust particles, enabling astronomers to map a region of sky at submillimeter wavelengths. The Hawaii-Japanese observation of the heavily studied field “SSA13” is the longest exposure (51 hours) which has yet been made with this instrument.

“SCUBA has produced a true revolution in submillimeter astronomy, and it is just fabulous to see the new fields that are opening up from planets around nearby stars to the tremendously exciting cosmological studies that are really opening up our view of the early Universe,”said Ian Robson, Director of the Joint Astronomy Centre, the operational headquarters for the JCMT and the United Kingdom Infrared Telescope.

The dusty galaxies discovered by the research team are forming stars at rates that are extremely high, a factor of 10 to 100 times higher than the rates of star formation in most optical sources. The detected submillimeter sources are less numerous than optically-observed sources, but in total radiate as much or more energy.

The only objects in the local Universe which have characteristics similar to those of the distant submillimeter sources are the “ultraluminous infrared galaxies” which were one of the major discoveries of the IRAS satellite. The infrared light emitted by these objects is produced by reradiation from dust, which has been heated by stars formed in an intense starburst and by the active galactic nuclei in these galaxies. The ultraluminous infrared galaxies are often formed by a strong merger between two gas-rich galaxies, and it is possible that the submillimeter sources at high redshift may be galaxies in the process of formation through the merger of smaller pieces.

The discovery of the submillimeter sources may require a major revision in deductions about the epoch of peak star formation activity. Optical surveys have concluded that star formation in the Universe peaked at a time when the Universe was already about three-quarters of its present age. However, it now appears that these surveys have missed an entire population of rapidly star forming galaxies, which may be located at greater distances and hence earlier times. A combination of both optical and submillimeter observations will be necessary to accurately trace the global star formation rate back to the time when primordial galaxies first assembled. The detection of galaxies in this submillimeter survey has opened up a new frontier for the exploration of the distant Universe.

The SCUBA maps and related information can be found at the following URL:

http://www.ifa.hawaii.edu/~cowie/scuba/scuba_int.html

JAC Internal Science Seminars

All visiting astronomers are encouraged to give scientific presentations to the JAC staff after their observing run. In addition, many of the JAC staff give presentation on their current research topics.

The seminars are organised by Gerald Moriarty-Schieven (**gms@jach.hawaii.edu**).

A list of those for the future and those given during 1998 can be viewed at:
http://www.jach.hawaii.edu/~gms/seminars/1998.html

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Distribution:

Information about new issues of the **JCMT Newsletter** is circulated to the community via the electronic distribution list held at the JAC, and also via the Canadian listserver. Anybody wishing to be placed on this mailing list should signup on the appropriate Web page.

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On-line Documentation:

All up-to-date information on the JCMT and instrumentation is maintained through links from the JCMT homepage on the World-Wide Web.

The JCMT homepage has URL:

http://www.jach.hawaii.edu/JCMT/home.html

Service Observing:

Applications should be sent by e-mail to the following:

Canada	jcmtserv@hia.nrc.ca
Netherlands	vdhulst@astro.rug.nl
UK (&amp International)	jcmtprop@jach.hawaii.edu

NEXT ISSUE DEADLINE

The absolute deadline for submission of science and/or technical articles for the next issue of this Newsletter is **31st January 1999**. All communications regarding this Newsletter should be sent via email to **gdw@jach.hawaii.edu**.

Acknowledgements

The JCMT Newsletter is the official publication of the James Clerk Maxwell Telescope. These issues are ONLY available in html format on the World Wide Web. There is no paper magazine that corresponds to these pages. This is taken to be a sign of the times, where most, if not all, of the readership has access to an internet terminal. It means that the information presented can be made more up-to-date. Notice that several of the articles now refer directly to other links on the Web both internal to JCMT and on the odd occasion to external sites. It also means that the rapidly dwindling cash supply available for printing booklets can be channeled into other worthy causes.

Contributions are solicited from recent observers, instrument builders and from the staff at the Joint Astronomy Centre.

Articles for **The JCMT Newsletter** may be submitted to me at any time. Please take note of deadlines for specific issues. If you wish to make any comments on the articles, please contact the authors. If you have any comments concerning the Newsletter itself, format and/or content, then please contact me.

The JCMT Newsletter is **NOT** a refereed journal but remains as the voice of the JCMT User community. It is appropriate that the content clearly reflect the state of the observatory, the availability of the instrumentation, and the quality of scientific output obtained. The former two features can be completed by the JCMT staff whilst the latter is primarily up to the user (and reader). Please contribute to your newsletter.

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Thank you for taking the time to read this Newsletter.

Graeme