THE JCMT NEWSLETTER

August 1994 Issue Number 3

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Message from the Director

The undoubted highlight of the last six months was the Jupiter-comet bash. The impact of the fragments of comet Shoemaker-Levy 9 and Jupiter ensured that all telescopes on Mauna Kea were firmly pointed toward Jupiter for almost two weeks in mid-July. There were two teams using the JCMT and elsewhere in this Newsletter Matt Griffin gives a first hand account of the excitement of the event. Gratifyingly the results were probably much better than the proposers might have expected and apart from the intrusion of a second event to the Islands, might have been even better.

This second event was linked with the comet bash, both violent, both making enormous local news and both occurring at the same time. This was the appearance of hurricane Emilia, the most powerful hurricane ever recorded in the mid Pacific. It was a class 5 hurricane with sustained winds of 160 mph and gusts up to 200 mph. There was great concern that it might deviate from its projected path of just skirting south of the Islands to a northerly direction which could have caused havoc similar to hurricane Iniki in 1992. Thankfully when it did move along a more northerly track, it slowed, rapidly weakened and dissipated as a tropical depression. Nevertheless, it brought thick cirrus and heavy showers and caused the JCMT to be closed for the best part of three nights. Snow flurries were observed on the summit during the worst of the weather. Emilia was immediately followed by tropical storm Fabio and now hurricane Gilma is heading due west, south of the Islands. This plethora of hurricanes is rare and will not help the weather statistics for the semester. The necessity of having good RxA backup programmes is clear.

On a much more positive note the RxG run coincided with by far the best extended period of low opacity for many semesters. For a seven day period from 26th February until 4th March the CSO tau never exceeded 0.07, and remained below 0.04 for over 70% of the time. This, together with the excellent performance of both the telescope and the new receiver contributed to the most successful run ever, with fabulous data being obtained. We await the results of the exciting science from this run with great anticipation. The JCMT-CSO interferometry run in February also provided excellent data including observations at 345 GHz.

The first serious experiment in flexible scheduling was undertaken by the Canadians during Semester 94A. The experiment included a mix of high frequency and intermediate frequency proposals and observers from all the programmes were present for all the time. Unfortunately the weather was excellent for nearly all the run and so some of the aspects of flexible scheduling were not fully explored. I will be continuing to push for more flexible scheduling in order that more science programmes can be completed and published in as short a time as possible. A major paper will be submitted to the November JCMT Board and I hope to circulate some of the general principles via email for user community comment priot to the Advisory Panel meeting in November.

The operations proceeded relatively smoothly during the semester with no major failures apart from the new digital SMU system. There were a number of small and niggling problems, including missing clock ticks, which caused pointing glitches and loss of some data. We believe that this is now solved. The new SMU was released in January after extensive testing but suffered a major failure in May when a power supply in the chopper servo failed; all four Ling vibrators, a stinger and a flex pivot were severely damaged. The exact cause of the failure is still not known, but the TMU had a failure at the same time, suggesting the cause was external to the SMU controller. All of the damaged components were replaced within two days, but this used up all of our spares. The failure occurred in the digital chopper controller, which was successfully commissioned last December. The old controller has been re-installed while the general protection ciruitry is improved, but since the old controller has the same design fault, we have imposed a 'ban' on anything other than single-axis chopping except by specific request.

The other major piece of work carried out over the last six months was the second change in the focal length of the telescope. This change was by 7.5 mm and required the insertion of shims under 120 of the most extreme adjusters in the outer rings. We believe that no further focal length adjustment will be required. Unfortunately, this work was hit by a period of severe weather accompanied by major snowfalls stretching from the end of January until the middle of February. This disrupted the heavy engineering period of 24-28th January and closed the telescope for a week from 11-18th February. Problems with the panel adjusters and holography receiver conspired with the lack of planets and further poor weather to prevent high quality beam maps being obtained. Our current knowledge of the state of the surface is best described as just adequate. The good news is that we believe the surface to be as good as it was last summer and further improvements are expected as more data are obtained and further tweaks are made to the surface. Some PATT observers will probably be required to `donate' an hour from their shift to allow these urgently needed data to be obtained.

Regular measurements have shown that the pointing has degraded over the past nine months. This is in part due to poor weather affecting the pointing runs but mainly due to inferior track models following adjustments to the loading on the antenna central bearing last November. We have just taken delivery of new inclinometers for an improved measurement system and one of the major projects scheduled for 1995/96 is work on the track and better pointing. As an aside, we have just been notified that the encoder manufacturer will no longer be able to relamp the encoders, which have filament lamps and a lifetime of only about a year. Although replacement LED encoders have been budgeted for, this is some years downstream. Innovative solutions will need to be found to solve this now pressing problem.

The science group turned their attention to the calibration of the heterodyne instruments after problems affecting RxB3i were noted in November. These were eventually traced to problems of layer separation of the IR blocking filter, thought to be caused by thermal cycling of the receiver. Reports on the fix of these problems, the progress of obtaining calibration spectra and the pitfalls in heterodyne calibrations are to be found elsewhere in this Newsletter. The DAS now has a better 750 GHz mode and experiments with on-the-fly DAS mapping are continuing. Information flow to users and general documentation are also areas which I have directed staff to give attention to over the last six months and users should expect to see significant improvements during semester 94B. The World Wide Web facility is gaining strength and popularity and in future we anticipate that this will be the medium for information release for the JCMT and perhaps even this Newsletter. The JAC now has a home page and users are encouraged to browse the contained information.

Excellent progress has been achieved in defining plans for the instrumentation programme for the next five years. Unfortunately, the delivery of SCUBA has again slipped but the two new heterodyne instruments are more or less on track. A design study for the B-Band array is now underway with a costed proposal to be put to the Advisory Panel and Board in the autumn. The B-Band array, including backend (MIDAS) is the next major instrument for the JCMT and will have a major impact. Users are encouraged to make their views concerning the importance of this instrument known to their national representatives on the Advisory panel prior to the November 16 Meeting.

It is clear that software is becoming an increasingly important component for all modern facilities. The first major steps have now been taken to move towards UNIX and plans are in place to upgrade to UNIX-based workstations over the next two or three years. The telescope software platform is now very stable and reliable but continues to be improved and upgraded. New utilities for observers were provided during the year and the on-line weather information in terms of atmospheric transmission and `seeing' should allow better real-time decisions to be made by the observers. The long term software/hardware plans will be prepared over the next few months and so I have asked the software group to produce articles for this Newsletter to remind users of the current status of JCMT software and the current long term plans. Users are encouraged to let myself, the software staff, or their national reps know their views.

Ian Robson,

Director JCMT

People, Events &Things

Bill Duncan has resigned from ROE to take up a position as a Product Manager at Oxford Instruments. Bill was Project Scientist for UKT14 and after the construction at ROE was shipped off to Hawaii to oversee its operation on the UKIRT. Once the JCMT snapped UKT14 for its own continuum purpose Bill became a `JCMT person' and remained a Support Scientist until his return to ROE in 1992. Since then he has been working with the SCUBA team and is a member of the JCMT Instrumentation Programme Management Group.

Rob Ivison has joined the ROE Astronomy Division in a position shared between the UKIRT and JCMT Support Groups. At the moment Rob is working on setting up a World Wide Web home page at ROE to provide users with information for both telescope.

Simon Craig has transferred to RGO to take up a position as a Project Engineer. Simon has been Mechanical Engineer at the JAC for nearly 8 years and was heavily involved with the UKIRT dome refurbishment work and with all aspects of the commissioning and mechanical improvements to the JCMT antenna and carousel.

Rob Millenaar has now completed his one year period of providing support for the DAS in addition to other engineering duties. Rob has now returned to NFRA, Dwingeloo.

Events

Congratulations to **Alex McLachlan** on being awarded an MBE in the Queen's birthday honour's list.

Congratulations also to **Frea** and **Adrian Webster** on their marriage on 19th August.

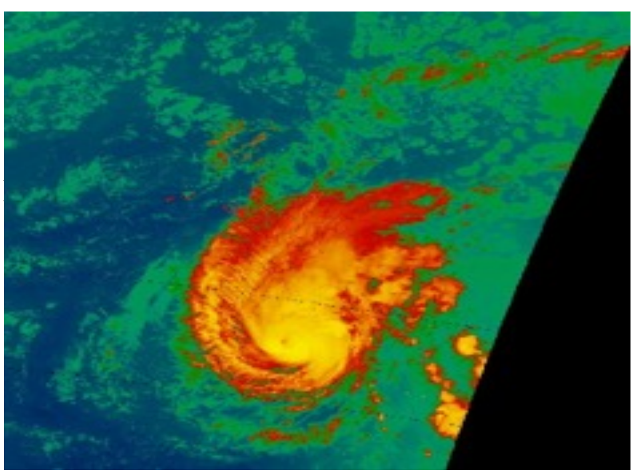

Figure. Hurricane Emelia.

Accommodation in Hilo for Extended

The JCMT Advisory Panel and JCMT Board have stressed how important they rate having accommodation available in Hilo for those making extended (say more than one week) stays in Hilo (as opposed to at Hale Pohaku). Therefore, I have organised an apartment in the Hilo Lagoon Centre. This has maid service and general amenities. JCMT visitors will be able to stay in this apartment rent free, but will need to pay for food, telephone and other incidentals. Those wishing to make use of this should contact me. It will be available on a first-come-fitrst-served basis, so book early. Let me stress that this facility is not available for those observers staying a couple of extra days to reduce data - it is specifically for extended stays.

When this apartment is not in use, it will be available for UKIRT visitors at the economic rate.

Director JCMT

High Altitude Medicals

The JCMT Board agreed at its meeting in May 1994 a new policy in respect of medical requirements for visitors to the telescope. Presently visitors require medical examination and certification; the new policy is based on the issue of a disclaimer which incorporates a medical alert. Once such a form has been approved it will be circulated via the Newsletter and via each PATT application. Until then, observers are still required to fulfill the high altitude medical examination.

Graeme Watt, ROE

Daytime Observing

Observers who expect to make use of extended hours should contact their support scientist well in advance of the run to allow us to take this into account whenever possible in planning our maintenance schedules. Note that during the daytime hours the pointing is frequently extremely poor due to very high refraction noise and highly variable opacity (given respectively by the phase monitor and CSO tau meter and displayed in near real-time on the telescope screen). The amount of extended time is monitored as part of our procedures to determine cost effectiveness.

The switch between first and second shift is deemed to take place at 1330 hours if both shifts wish to make use of the daytime.

Director JCMT

JCMTINFORM Enters CYBERspace

Owing to the imminent demise of the ROE Starlink VAXcluster, the information provided by JCMTINFORM has been copied onto the new ROE World Wide Web server. The original VAX-based system will continue to be supported until 1st December 1994.

Access to the ROE WWW server can be obtained using a variety of hypertext browsers, but the `Mosaic' (mouse-driven; Xwindows interface) and `Lynx' (text-only interface) browsers come highly recommended. The ROE WWW server has the following URL:

http://www.roe.ac.uk/

Once there, click on JCMTINFORM and follow the links to the information you require.

JCMTINFORM covers a variety of topics, including:

the service observing programme (what we provide and how to collect yours);

how to obtain PATT observing time;

telescope time allocations for recent/current semesters;

visiting Hawaii, e.g. the accomodation request form;

data for observers, e.g. the pointing catalogue;

where to find the data and beam map archives;

contacts for specific JCMT issues;

news items;

links to the on-line User Manual at JAC.

Users who would like to see their pre-prints available on the Web (and particularly visible to other members of the JCMT user community) can e-mail their LaTeX or Postscript files to me for incorporation into JCMTINFORM.

Rob Ivison, ROE

rji@roe.ac.uk

INSTRUMENTATION

Summary of JCMT Instrumentation for Semester 95A

As little has changed regarding JCMT instrumentation since the last issue of the Newsletter, only a brief summary is given here. A more complete version of this text is maintained in the e-mail fileserver (ask for file `receivers.summary'). Complete information suitable for preparing proposals can be found in `The James Clerk Maxwell Telescope: A Guide for the Prospective User' which is available over the e-mail fileserver (file `userguide.ps'), or through the offices of the partner countries or from the Joint Astronomy Centre in Hawaii. The User Guide also may be browsed on the World-Wide Web (home page http://jach.hawaii.edu/).

Three SIS mixer receivers form the core of the spectral line program, A2, B3i and C2. One other SIS receiver (G) is available via collaboration with the MPE, Garching group; contact Dr. L. Tacconi

(LINDA@MPE-GARCHING.MPG.EDU)

for further information.

B3i is expected to be replaced by a dual-channel receiver (B3) early in 1995. In the latter part of semester 95A, a dual-mixer dual-waveband SIS system (Receiver W) for the 450-490 and 650-690 GHz windows may be commissioned. Because of the uncertainties in the delivery dates for B3 and W, users are advised to prepare programs which are suitable for the current equipment. See elsewhere in this Newsletter for additional information on these systems.

Until displaced by SCUBA (see below) the UKT14 bolometer system will be available for continuum observations with filter wavebands at 2, 1.3, 1.1, 0.85, 0.8, 0.75, 0.6, 0.45 and 0.35 mm. The aperture of the bolometer can be adjusted between 21 and 65 mm. Sensitivities range from typically 0.3 through to 10 Jy/sqrt(Hz) under good photometric conditions. Photometry is normally carried out with full aperture, and mapping with an aperture matched to the antenna beam. So long as UKT14 is available, the Aberdeen/QMW polarimeter also will be offered as an optional accessory for it. Observations are possible at 1100, 800, and 450 microns.

The submillimetre bolometer camera SCUBA is not expected to arrive in Hilo before spring of 1995. It will not be available for astronomical observations until some time later following a lengthy commissioning period. **Regular proposals for the use of SCUBA will therefore NOT be accepted for semester 95A.** Additional information appears elsewhere in this Newsletter.

Henry Matthews, JAC

New Instruments

Do not apply for any of the new instruments listed below for semester 95A.

Policy

Although there has not been any change in policy regarding the release of new instruments, it is probably best to restate it. Instruments will not be released to the user community until they are fully commissioned. This includes determining their performance under a variety of conditions, testing of observing modes and ensuring adequate calibration. For some complex instruments, and SCUBA is the prime example, to enable users to obtain astronomy at the earliest opportunity, the commissioning will be done in a phased way. Opportunity will be announced to the community during the commissioning period for short `taster' observations to be done in serviced mode by members of the commissioning team. This plan was approved by the JCMT Board and is set out in the July 1993 Newsletter, p17.

One aspect of the above which may not be immediately appreciated by users is that unless the commissioning time occurs in clear weather, the full commissioning cannot be completed. This will further delay the release of the instrument. I am not prepared to release an instrument for which we cannot accept responsibility for the quality of the data and/or for which we are still modifying aspects of the instrument or the operating software. The weather factor is clearly more critical for the higher frequency instruments. Therefore I intend to request of the ITAC a block of time for commissioning of new instruments for semester 95A, to be flexibly scheduled in order that the receivers can be fully commissioned and released to the community as soon as possible. This is not only a sensible practice in general but is also essential for RxB3 and RxW as there is now a critical phasing of old/new instruments in the receiver cabin. Although this may cause some short-term frustrations for the users, I am convinced that the long-term gains are completely justified. The articles on calibrations in this Newsletter show the concern which we feel for our current understanding of the instrument suite at the JCMT and this is one of the major thrusts of the Science Group at the current time.

By the time of the ITAC meeting, we will be in a much better position to assess the precise delivery dates. Users are informed of changes in the email server or WWW.

RxB3

This instrument is scheduled for delivery to the telescope in the spring of 1995. Therefore observers should expect to use it during the middle to end of the semester but should plan their programmes on the basis of RxB3i performance. Although we anticipate that the commissioning of RxB3 will be relatively straightforward and currently we do not anticipate delays to the release of RxB3 to the users, past experience suggests that things are never so straightforward in real life. Applicants for B-band programmes will either get RxB3i or RxB3 depending on how they are scheduled in the semester. The latter should be thought of as a bonus.

SCUBA

As most of the readers will be aware, SCUBA has suffered a delay in shipping to Hawaii and at the time of writing the delivery date is uncertain. This has caused the need for a `second round' of continuum proposals to be called for semester 94B. This was unfortunate and highlights the problems of trying to anticipate the delivery of new instruments when notification of availability, applications for time and scheduling of the telescope are so far in advance of actual delivery. Therefore, rather than apply the same process as for semester 94B, where UKT14 was only stated to be available for the first three months with the anticipation that SCUBA would then take over, I propose a different plan for 95A. Observers should apply for UKT14 on the usual basis. When SCUBA arrives and commissioning begins, then at some point there will be a general call to the astronomical community for SCUBA serviced proposals during the commissioning phase. This might include observations from any PATT proposals which have been `bumped' through commissioning of SCUBA. I leave the details of this aspect to the individual TAG's who might have different views as to how they wish to proceed.

RxW

This receiver, operating at C and D bands, is expected to arrive in Hilo in early summer 1995. This receiver will require a more extensive commissioning period than RxB3 and therefore it is appropriate to issue a call for proposals for serviced observations to be undertaken by the commissioning teams in the same manner as SCUBA. Therefore, no RxW proposals will be accepted for semester 95A. Observers should consult the information system, JCMT_INFO, WWW or email exploders for the announcement of opportunity for observations. Programmes requiring C-band will continue to use RxC2 until a time when it is displaced by the commissioning of RxW, at which point they may have their observations done in serviced mode by the commissioning team, (as for SCUBA) at the discretion of the national TAG. As noted in the policy section, the removal of C2 at the earliest point is to ensure that all the available C-band weather can be utilised effectively for the speediest commissioning RxW (at C and D) for the users. This may also cause some scheduled C-Band proposals to be `bumped' and again I look to the TAG's to indicate how they wish the commissioning C-band observations using RxW to be determined. An announcement will be made regarding D-band through the electronic news media.

Ian Robson,

Director JCMT

Innovative New Projects

At its May 1994 meeting the JCMT Board approved three innovative new instrumentation projects. These were as a result of the call for proposals published in the last JCMT newsletter.

The response was very encouraging with six excellent proposals. The proposals were first refereed for scientific merit by a referee from each of the partner countries plus a specialist referee, and then were placed in priority order by the JCMT Advisory Panel.

The three proposals which were funded are:

- Proposal to upgrade Receiver C2 to E-band (800 to 900 GHz). *B.N. Ellison, L.T. Little & W.R.F. Dent* :-- When RxW (which will operate at both C- & D-bands) is delivered in 1995, RxC2 will be returned to RAL and will be refurbished as an E-band receiver.
- A Proposal to Investigate the Design of SIS Receivers for Submillimetre-Wave Extragalactic Astronomy. *S. Withington, R.E. Hills & R.G. McMahon* :-- This proposal is to investigate a number of technical developments aimed at improving the telescope for extragalactic spectral line work. As part of the study a prototype broad band SIS mixer will be developed and tested.
- A Common User Polarimeter for SCUBA. *P.A.R Ade, A.G. Murray, M.J. Griffin, W.K. Gear, J.P. Vallée, P. Bastien, W.S. Holland & M. Tamura* :-- This is the first step towards the development of a common user polarimeter for SCUBA. The work will involve assessing the viability of using the existing UKT14 polarimeter with SCUBA and the development of achromatic wave plates and associated hardware for a common user polarimeter.

Adrian Russell, Head,

JCMT Instrumentation Programme

PATT INFORMATION

PATT Application Deadline

Deadlines for receipt of JCMT applications for semester 95A are:

for Netherlands applications:

15th September 1994

for UK and International applications:

21st September 1994

for Canadian applications:

30th September 1994

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 (apart from those funded directly by the partners) count as International unless they are the PI on an application, when it should be forwarded to the appropriate national TAG.

Please help us to manipulate a consistent set of applications by only using the new revised PATT3. Older versions will still be accepted but the Technical Secretaries will frown at you and send you reminders to use the new one in future.

Country paying salary of Principal Investigator

Canada	**Netherlands**	**UK or Other**
JCMT Time Allocation Group,	JCMT Program Committee,	PATT Secretariat,
Herzberg Institute of Astrophysics,	Leiden Observatory,	PPARC,
100 Sussex Drive, Ottawa,	P O Box 9513,	Polaris House,
Ontario K1A 0R6	2300 R A Leiden,	Swindon, SN2 1ET,
CANADA	NETHERLANDS	UNITED KINGDOM

PATT ITAC Report for Semester 94B

Allocations

The individual partner TAGs hold meetings in their respective countries prior to the PATT session to assess applications 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 to be considered

UK status	34
Canadian status	29
Netherlands status	11
International status	8
University of Hawaii	9
TOTAL:	**91**

The PATT meeting for semester 94B was held at The Falcon Hotel in Stratford upon Avon, UK on 2nd & 3rd June 1994.

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 such a JCMT staff member. International applications are assessed by the Chairpersons of the national TAGs at the ITAC meeting.

Time Available	**(in 16-hour nights)**
No. of nights in semester 94B	183
Engineering & Commissioning	23
University of Hawaii (10%)	16
Director's discretionary use	4
Available for PATT science:	**140**

The above table indicates the order in which nights are removed from the total available for the semester. Semester 94B covers a winter period from 1st August 1994 through 31st January 1995 inclusive. The JCMT is not open for observing on the night of Christmas Eve.

Awards	**16-hour nights**
UK status	73.5
Canadian status	33.5
Netherlands status	27.0
International status	6.0
University of Hawaii	16.0
TOTAL allocation:	**156.0**

The number of successful applications was 62. For interest, the spread of these applications was 3 solar system, 12 stellar, 27 galactic and 20 extra-galactic. The average length of time awarded per application was 4.1 shifts.

For those not familiar with the JCMT Board formula, the total time requested is divided amongst the PI and collaborators. 50% of the time is awarded to the country paying the salary of the PI. The remaining 50% is divided equally over **ALL** investigators (including the PI).

Attribute by JCMT Board formula	**nights**
UK	60.0

Canada	32.0
Netherlands	24.0
International	24.0

The International attribution of nights again come out much higher than those from direct PI calculation. This indicates that a significant fraction of time is being awarded to collaborations with non-partner co-investigators but with a member of the partner consortium being PI on the applications.

Instrument distribution

UKT14	29%
RxA	17%
RxB	35%
RxC	19%

There is a strong interest in use of the C-band receiver with a corresponding drop in requests for B-band. The reduction in allocation of time for UKT14 is due to reduced request (see below). Observers are anxiously awaiting the arrival of SCUBA to continue their programmes.

Long-Term Status

Application L/M/94A/U19, approved for long-term status for three semesters, was given 3 shifts. Since the continuum instrument may be changed during Semester 95A an observing report and re-estimate of the integration times may be required at the next UK-TAG meeting.

Engineering & Commissioning

The engineering & commissioning time for 94B involves considerable work to improve the surface accuracy and receiver efficiencies as well as further modifications to the SMU and rewiring work on the computer room.

No time has been allocated for commissioning of RxB3 or SCUBA. Further details on the progress of these instruments will be made available as soon as possible through the JCMT_INFOfile server and national information distribution systems.

Observatory Backup Programme

The Observatory Backup (M/94B/I09) was given Long Term status for 2 semesters for CO (2-1) and 13CO (2-1) mapping of the nominated sources and any others suggested to the ITAC as long as there is no conflict with future allocations. All partners agreed to use this programme as a `last resort' backup when the weather deteriorates sufficiently to prevent observers using their own allocated backup but not sufficiently to justify closing the observatory.

Service time

Allocations for this semester are:

CDN	=	8 shifts allocated;
NL	=	6 shifts allocated;
UK	=	8 shifts allocated

Changes to Semester Numbering

By the new convention, semesters that run from February through July are designated as `**A**' and those running from August through Janaury as `**B**'. These are to be preceded by the last two digits from the year. Therefore the current semester from Aug'94 through Jan'95 is known as **94B**. Applications for the forth-coming semester should refer to semester **95A**.

Redesign of the JCMT Application form

A new design of application for observing time form, more appropriate for the JCMT and which can be common to the partner countries, is under discussion. Items specific to a particular country will be allocated their own layout on a separate page. The process is well under way with a new form (PATT3) now being formatted but it is unlikely to be available for use before semester 95B.

Shortfall of UKT14 Applications

Following the announcement that SCUBA would be delivered to the telescope in Semester 94B, the continuum instrument UKT14 was only offered to the community for observations during the first half of the semester. Since SCUBA will now **not** be delivered in Semester 94B, the ITAC decided to issue a further call for proposals for the use of UKT14 during the second half of Semester 94B. This call has now been completed and the application are undergoing processing via the normal procedures in order to fill the allocated slot. In the case of the UK community this is a 26 shift (roughly 13 full night) period in January. The other partners will use time out of their service allocations for this purpose.

Graeme Watt (ITAC Technical Secretary),

ROE

PATT No.	**Principal Investigator**	**Shifts Given**	**Title of Investigation**
C01	Bridges T J	3	A CO(3-2) map of NGC 1275 (Perseus A)
C03	Kwok S	3	C I in carbon-rich proto-planetary nebulae

C05	Moriarty-Sch G	3	Mapping dense gas in circumprotostellar environs
C06	Vallee J P	5	Submillimetre polarimetry of molecular clouds
C07	Wilson C D	5	Molecular clouds in IC 10
C08	Mitchell G F	4	Search for triggered star formation in NGC 7129
C09	Hasagawa T I	2	Observations of non-dissociative shocks in molecular clouds
C10	Scott D	3	Search for C II emission from high-z absorption systems
C11	Matthews H E	3	C I in optically thin shells around evolved stars
C12	Matthews H E	4	Search for NH2 in cold dark interstellar clouds
C16	Hajjar R	4	Mapping & photometry of disksd YSOs
C18	Seaquist E R	4	H27a recombination line in M82
C20	GiannakopoulouJ	4	Hot molecular gas near giant extragalactic H II region
C21	Matthews H E	1	Submillimetre photometry of asteroid 1620 Geographos
C23	Lee S -W	4	CO observations of NGC 3044
C27	MacLeod J M	3	Search for high-velocity neutral jets in outflows
Y/C05	Papadoupoulos P	4	Temperature & density gradients of molecular gas in Seyferts
I02	Zuckerman B	4	Gas in dusty protoplanetary systems
I03	Molinari S	3	Dust properties of progenitors of ultracompact H II regions
I04	Greaves J S	1	Density threshold for star formation
I07	Skinner C J	4	CO observations of red giants
H01	Sanders D B	2	Molecular gas properties of Seyfert galaxy nuclei
H02	Evans A S	7	Submillimetre spectroscopy of high redshift galaxies
H03	Chambers K	3	Search for C II emission from high-z radio galaxies
H04	Senay M	7	CO emission from comets
H05	Carpenter J	6	Kinematics of molecular cloud cores
H06	Carpenter J	2	The structure of massive dense cores
H07	Dudley C	1	1.1 mm observations of IRAS 0857+39
H09	Ladd E F	4	Submillimetre continuum observations of stellar

density enhancements

N01	Hogerheijde M	8	HCO+ in YSOs
N02	Miley G K	11	C I in high-z galaxies
N03/5	Israel F P	10	C I, CO(4-3) & CO(3-2) maps of galactic centres
N04	Henning Th	6	CS in stellar disks
N06	Helmich F P	5	Chemistry in W3
N09	Tilanus R P	2	H2CO in NGC 3079
N10	JaffeW J	2	C I in cooling flows
N11	van Dishoeck E	2	T Tauri (SBI)
94A/U19	Zylka R	3	The variability of Sgr A* (Long Term Application)
U01	Doyle J G	2	Are all dust shells different?
U02	Minchin N R	9	C I observations of edge-illuminated molecular clouds
U03	Barlow M J	4	Submillimetre observations of Vega-excess stars
U04	Dent W R F	1	CO clumps in a symmetrical high-collimation jet
U08	Aspin C A	4	C18O observations of young stellar clusters in NGC 1333
U09	Davies J K	2	Molecular content of comet P/Borrelly
U10	Minchin N R	4	C I observations of molecular outflows
U11	Rottgering H	2	CO emission in powerful compact radio galaxies
U12	Longair M S	4	A study of dust in z=1 radio galaxies
U16	Dent W R F	3	Correlation between gas & dust in HH progenitors
U17	MathieuR D	5	Evolution of disks around young binary stars
U18	Marscher A P	5.25	Multi-frequency monitoring of bright g-ray blazars
U19	Russell A P G	6	Test whether C I/CO is enhanced in shocked regions
U22	Scott P F	6	Line observations of a new sample of FIR embedded cores
U23	Rottgering H	4	CO observations of AGN and high-redshift quasars
U24	Hills R E	3	Search for C+ emission in galaxy at z=4.26
U25	Hills R E	5	Protostellar observations with the JCMT-CSO interferometer (SBI)
U26	Padman R	5	The Jets and Bowshocks of RNO43
U27	Padman R	4	Interferometric studies of multiple T Tauri systems

(SBI)

U29 White G J 11 Study of CO fractionation in molecular clouds

U31 Emerson J P 4 Mapping submillimetre continuum structure in embedded YSOs

U32 Griffin M J 5 Luminosity:circumstellar mass relation in YSOs

U33 Evans A 2 Millimetre continuum observations of cataclysmic variables

Note: There remain 26 shifts of UK time as yet unallocated.

About Schedule Creation

In the beginning is the PATT meeting, somewhere in the UK ~2 months before the start of a new semester. At that time a great light shines upon the schedule, in that time allocations are set. And yet there is trouble on the face of the deep, and multitudes of constraints gather round. Problems of source availability rise up and are fearsome.

Time allocation is constrained only by number of shifts, but scheduling is affected by distribution in RA. It would seem that the only region of interest in the Galaxy is Orion/Taurus. The congestion for semester 94A was so severe that ITAC was asked to set priorities, and some observers were rather surprised to find their objects of interest accessible for only half the scheduled time. For other parts of the sky specific programmes can generally be placed within two weeks of the ideal time, although the offset can get pushed to a month. For some programmes, such as those with two sources twelve hours apart in RA, the very concept of 'ideal time' becomes a little fuzzy.

Constraints upon the schedule are numerous: Service time also has RA preferences; flexible scheduling requires programmes with compatible receiver requirements to be adjacent; minimising travel time and costs for observers requires other programmes be adjacent; E&C has very restricted times, with major engineering (now 'Eng') blocked in as dictated by the overall engineering programme at JAC and by the need to avoid conflicts with UKIRT which competes for the same engineers; suitable times for measurement of telescope and receivers (now 'C&C') is controlled by lunar phase for efficiencies, availability of suitable planets for beam maps, RA ranges for spectral line standards, and by a general need to be spread out in time; DDT requires a reasonable spread in time and RA; interferometry time is dictated by negotiations with CSO; UKT14 is unavailable for 5 days every 5 weeks at times that avoid weekend work with its attendant overtime; Rx C2 and B3i are each unavailable for 7 days every 2 months; Rx A2 is unavailable for 7 days every 3 months which is particularly troublesome because everybody wants A2. Final insult in the convoluted process of assembling a schedule is to have it all working perfectly except for a four-shift programme that must fit into a three-shift gap.

Another important set of constraints are the 'impossible dates' listed by observers, further complicated by the large time lag between proposal writing and schedule creation during which the lists change substantially. The custom has been to distribute a tentative schedule which provokes a flood of replies detailing previously unmentioned meetings, teaching requirements, time scheduled on other telescopes, conferences, holiday plans, etc, etc. Reworking the schedule on the basis of such replies is an iterative process that converges slowly with much anguish, wailing and gnashing of teeth. In future I intend to solicit, by e-mail, an updated list of 'impossible dates' before creating an initial schedule in an attempt to avoid the iteration process altogether. To aid in this, JCMT users are respectfully requested to provide a working Internet e-mail address on their proposal. An honest attempt will be made to avoid 'impossible dates' but it is not always possible.

Chris Purton, JAC

STATISTICS

Weather and Fault Statistics for Semester 94A

Introduction

The following tables present the weather loss and fault loss for semester 94A. Full details are stored on database at the JAC and interested readers are referred there for further information.

Graeme Watt, ROE

Iain Coulson, JAC

Month	**Avail Hrs**	**Extend Hrs**	**Primary Loss**	**%**	**Backup Loss**	**%**
February	448.0	12.6	165.5	36.9	6.0	1.3
March	496.0	41.7	163.5	33.0	1.5	0.3
April	449.0	27.6	40.3	9.0	0.0	0.0
May	488.0	22.8	58.0	11.9	0.0	0.0
June	480.0	36.3	68.0	14.2	0.0	0.0
July	496.0	28.9	180.8	36.4	12.0	2.4
Total	2857.0	169.9	676.1	23.7	19.5	0.7

Table 1: *JCMT weather statistics for semester 94A.*

Month	**Avail**	**Total**	**ANT**	**INS**	**COMP**	**SOFT**	**CAR**	**OTH**

February	448.0	24.4	5.3	11.7	0.3	7.0	0.0	0.1
March	496.0	2.6	0.0	1.5	0.0	0.0	0.0	1.1
April	449.0	8.3	1.2	3.3	0.0	0.	0.0	3.3
May	488.0	35.5	24.5	9.2	0.3	1.3	0.0	0.0
June	480.0	7.4	0.0	2.3	2.7	0.2	0.0	2.2
July	496.0	20.1	0.3	10.8	6.6	0.6	0.0	2.0
P(hrs)	2857.0	98.3	31.3	38.8	9.9	9.6	0.3	8.7
P(%)	**4.5**	3.4	1.1	1.4	0.3	0.3	0.0	0.3
B(hrs)		8.9	0.0	6.2	1.4	0.0	0.0	1.3

Table 2: JCMT fault statistics for semester 94A. 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 is the time lost to Backup projects. **The total clear time lost (including backup time) for semester 94A is 4.5%.**

TECHNICAL NEWS

JCMT Software Group

Introduction

For most of the last few years the efforts of the JCMT software group have been fairly tightly focussed on the on-line control and data-acquisition systems, and particularly on development on the Vax computers. However, in the last year or so our focus has begun to widen. The installation of Unix systems, which began in 1992, is now well underway. With increased software support, we now have the ability to address other areas, such as off-line utilities and enhanced data reduction facilities. Although the basic framework for the on-line systems is now relatively stable, it's limitations are becoming more obvious, and we are starting to consider some more major design changes in order to provide a more flexible and efficient system.

Individual areas which will have specific impact on Users are described in the following articles. The purpose of this article is to give a broad overview of the main areas of work currently being undertaken by the JCMT software group, and a general indication of our plans for the future.

Main Areas of Work

The efforts of the group falls into four main areas:

* continued development of the on-line system (support for new instrumentation, support for engineering work, new observing modes).

* development of facilities for visiting astronomers, including support of utilities and `wishlist' items and on-site data reduction.

* investigations and developments of new systems (e.g. the database).

* maintenance (bug fixes, ADAM and Starlink Upgrades, etc).

The distribution of effort between these categories is such that approximately half our effort goes into continued development of the existing system, approximately 10% into utilities and wishlist items, and around 30% into new systems. The number of known bugs in the on-line system is now rather small but new ones continue to surface from time to time. These, together with the usual maintenance requirements takes the remainder of the efforts of the group.

The following sections explore the three main areas in more detail.

Continued Development of the On-line System

As noted, this continues to take the bulk of the effort of the software group. The obvious major item is preparation for new instrumentation - RxB3, RxW and SCUBA. JAC staff are working closely with each of the instrument groups to ensure that the integration of these instruments into the JCMT control system goes as smoothly as possible. An area which has grown in importance as the telescope matures is to provide computing support for new engineering projects. For example, software development has been required for the acquisition and reduction of carousel strain gauge data, and we are now working with astronomers and engineers on the new inclinometry system. Support for the instrument group has also increased in the past year or so; with projects such as improved ICL procedures to simplify the measurement of receiver efficiencies. Interferometry is another project which has required considerable software effort.

Finally, we are continuing to make significant developments to the observation control system. A prototype scheme for heterodyne rastering with the DAS is under development. We plan to make more general improvements to the DAS software (improved calibration techniques, more flexible configuration software) in the fall, in collaboration with Hans van Someren Greve, who will be visiting from Dwingeloo. We also continue to investigate methods of reducing the observing overheads. We have recently moved a Vaxstation 4000/60 to the summit, to take some of the general system overheads off MWTVAX, and we are considering replacing MWTVAX with a model 4000, if the work required to install the appropriate SCSI interfaces is not prohibitive.

Facilities for Visiting Astronomers

Apart from actually improving the software involved in the real-time data acquisition, we are also trying to improve the ancilliary service provided to visiting astronomers.

One of the most visible manifestations of this has been the provision of Unix workstations at the summit, at Hale Pohaku and in Hilo. These facilities are briefly described in a following article by Remo Tilanus. As noted by Remo, the Unix versions of SPECX and JCMTDR should be available soon; many of the most popular alternative data reduction packages are also available (with data input via FITS). Although CLASS might be the most common alternative to SPECX, we have already had visiting astronomers reduce their data with IRAF - complete with graphical displays labelled in Angstroms! Along with the introduction of the Unix systems, we have installed an improved guest account allocation procedure, which will give visiting astronomers access to a private account accessible at all sites on both Unix and VMS systems.

We are also starting to devote some time to software items which do not have a major impact on the observing system, but which make life a little bit easier or simpler for visiting astronomers - the `wishlist' and improved support for `utilities'. Wishes are simple upgrades to the on-line system which do not require a serious specification or project plan. Utilities on the other hand are generally off-line packages which have been written outside the software group (either by local support staff or other establishments) and which we are now helping to support.

As a starting point for the wishlist, we have collected all the outstanding requests from local support staff, along with input from visiting astronomers into a single document - `The software wishlist' (MTUN/154). This summarises existing requests, and their current status - either in progress, pending due to lack of effort, or rejected as being either too ambitious or not considered to be worth the effort. This latter determination has of course been made after consultation with support scientists, and we will continue to have regular meetings of the JCMT science group to assess the relative merits of proposed work. Examples of recently or almost completed `wishes' include the addition of phase and transmission data to UKT14 data-files, and the provision of spectral-line fivepoints. Users who would like to look at the current wishlist should use anonymous FTP to get the file

\tt/pub/jac_docs/jcmt_docs/mtun154.tex

As noted in MTUN/154, visiting astronomers are encouraged to e-mail to Mary Fuka any requests which they might have for these sorts of small improvements.

Until recently, the utilities were not supported by the software group. Although we certainly don't wish to imply that only members of the software group are competent to write software, there have been problems in the past with multiple divergent copies of the same item, and with packages being `broken' either by upgrades to the on-line system or simply the genuine passage of time (e.g. changing ephemerides). Starting with the most important items, our plan is to move the software into a single central location, identical over sites and as far as possible operating systems, and clearly identify the support scientist(s) and member of the software group who will take responsibility for continued development and correct installation.

Finally, in all of this work we hope to significantly improve the documentation available to users. We will be working closely with Henry Matthews in this area to make documentation more accessible (both physically and in terms of content). We expect to make much of this documentation available on-line via the World Wide Web, and encourage users to explore this system.

Recent and Proposed New Developments

One of the largest new developments which has come to fruition in the last year has been the installation of Unix systems in Hilo, at JACH and at the summit. Although these are currently being used mainly for data reduction and new applications such as the database, we do plan to slowly migrate the real-time systems away from the Vaxes. The first instance of this will be SCUBA, which will use the Unix version of ADAM.

The relational database management system itself is described by Remo Tilanus in an accompanying article. As well as forming the basis for the astronomical data archive, this will provide us with powerful tools to manage instrument and other engineering data.

We have in the last few months started considering some more major re-designs of the on-line systems. Although we now have a stable, relatively bug-free and reasonably flexible implementation of the observing schemes as first envisaged 5-10 years ago, as the system has matured this very process has caused it's shortcomings to become more obvious.

We are continuing to modify the observation control task (CONTROL) to provide additional observing modes and improved efficiency, but it is clear that CONTROL is nearing the end of its useful life. One of our primary goals therefore is to replace this task (and associated ICL procedures) with a more efficient and flexible system which also provides the additional features missing from the current system. An upgrade or replacement for the existing GSD data-storage system, which is also failing to meet current demands, will probably be done at the same time.

Apart from the CONTROL task, at a lower level we wish to upgrade the software associated with controlling the telescope. The actual telescope servo is closed in a PDP which is unique at the JCMT, is poorly documented and contains custom interfaces. The fact that it has performed as well as it has is a tribute to the original design, but it really needs to be replaced by a more maintainable system. At the same time, control of a lot of the the existing hard-wired analog electronics (interlock monitoring systems and so forth) could be moved into the new telescope computer. This will allow us to implement some much-requested improvements to the operator interface. Finally, we would move some of the near real-time processing currently performed by the Vax into this telescope computer.

SCUBA will be delivered as a Unix ADAM system, and will come with a user interface based on a queueing system executing pre-defined observation definitions . Although initially this system will be separate from the heterodyne system, we will be working towards providing a consistent interface to the two systems. The current JCMT instrument development programme includes the delivery of a heterodyne array receiver (initially 16 elements) and matching multiple-input DAS in 1998. This will have control requirements far in excess of the existing heterodyne equipment. Finally, we wish to generally improve the user interface, and particularly improve error reporting and logging facilities.

In performing these upgrades, we will be constrained by the requirement that any new system will have to interface to a significant amount of existing software; we are certainly not going to re-implement everything from scratch. However, we are investigating whether there are tools other than, or in addition to ADAM which it may be appropriate to use. For example, the Tcl command language, and its graphical interface Tk has become a widespread de facto standard in the scientific community. It has already been interfaced to the ADAM message system at ROE and may well be used for the SCUBA queueing system.

A second possibility that we are considering is the use of the AAO real-time system, DRAMA, for new developments to the control system. Developed at the AAO as a result of experience gained with ADAM, it is portable across operating systems, has an efficient message system, and interfaces well to modern standards such as X and Tcl/Tk. An enormous attraction of DRAMA is it's ability to interface to an existing ADAM system, both from the point of view of exchanging messages, and in terms of the similar paradigm. The possibility that the appropriate parts of DRAMA might be easily ported to run under OS/9 is something which we intend to investigate further.

Given the potential impact of Gemini and UKIRT development at the JAC, we have not ruled out the possibility of using EPICS for parts of the system. Once again, this is a package which is generating widespread interest in the astronomical community. It might be particularly attractive for the `PDP replacement' for example where it would be well suited to the monitoring of motor drive currents, antenna leg temperatures, general weather parameters, emergency stop interlocks and so on. It is not clear yet however whether the benefits of EPICS outweigh it's costs, especially when a GUI competitive to that provided by EPICS exists in TCL/Tk.

Final Remarks

The requirements for new instrumentation are rather well defined and efforts to prepare for these will be given the highest priority. Our plans for the support of utilities and wishlist items are also well in hand. The route forward on major new upgrades is somewhat less clear - for example, we are currently awaiting with interest the outcome of the ADAM Review, and are also monitoring closely the changing plans of the Gemini Controls Group. At the moment we are using the current system along with a variety of other input to provide the baseline specification for future upgrades, and are still exploring the potential of new tools such as TCL/Tk. However, we hope to start work in earnest on some of these developments in the next six months.

I hope that this article has given a flavour of where we are going. If anyone would like more information, or has any comments or suggestions they should feel free to contact me.

Richard Prestage, JAC

A RDBMS for the JCMT

Introduction

The Director of the JCMT proposed in 1993 that the responsibilities for a JCMT data archive be moved to Hawaii and funds were set aside for a new archiving system. Through discussions in Hawaii this project evolved into the use of a commercial Relational Database Management System (RDBMS) for the archiving of both astronomical and also engineering data of the JCMT. The necessary software and hardware has now been acquired and implementation of the RDBMS is in progress. In this article I want to give a brief outline of the project, as well as the changes that users can expect over the course of the next year in terms of the operations at the telescope and the archiving of their data.

But first I should perhaps say a little bit about the background of the project. Given that the JAC is moving towards UNIX this immediately presented the question what to do with the current VMS-based system ARCQUERY. Based on my experience with a commercial database system at the Owens Valley MM-array, I strongly suggested we pursue this route rather than trying to do a rewrite of ARCQUERY. Given the hundreds, if not thousands, of person-years invested in the commercial packages, there is no chance that any effort the JCMT can come up with is going to produce something that can compete. Just like high-level programming languages, commercial RDBMS's offer a good isolation from the underlying hardware i.e. an almost complete transparency regarding the actual location of the database on the network and the actual method of storing the information on disk.

In addition, the commercial packages have moved beyond a mere archival functionality and are dealing with the on-line and real-time management of information such as world-wide ATM transactions. Just recording a transaction is not enough: the RDBMS has to check authorization, availability of funds, guard against simultaneous access and make the updated information instantly available. Moreover, the system has to survive crashes, ATM malfunctions, as well as losing communication links (next time you open an account ask the bank whether they first update your account balance or first pay you the money: both options are in use). Coming from such a money-sensitive background RDBMSs have evolved to be extremely robust and failure-resistant. Also, in general there is multi-platform support and a sophisticated user interface dealing both with simple character based VT100 terminals as well as the latest X displays.

Aside from managing an astronomical archive, a RDBMS is an extremely powerful tool to also manage all the configuration and engineering data associated with the telescope. It is in this use of a RDBMS, rather than the archive, that I see substantial advantages it might bring both for the JCMT staff as well as the users. We have dubbed such a system a `Telescope Management System' (TMS; for lack of a better term) as opposed to the `Archive' which becomes only one part of it. Below I will explain each of these in more detail, as well as the overall proposal of what I think the actual implementation will look like.

After an evaluation of a number of commercial RDBMSs, the JCMT has purchased SYBASE from Sybase, Inc. Not only was this RDBMS technically and financially the most attractive, it is the one in use by e.g. the Canadian Astronomical Data Centre and Owens Valley, and the one on which I have hands-on experience.

Overall scheme

The over-riding philosophy behind the plans is to put the local effort where it uniquely benefits the JCMT observing and operations, and not where it re-invents wheels. Not surprisingly, this also coincides with my own interests. As a consequence, we will try to adopt an existing design for the Archive and put all the effort in the Telescope Management System. Specifically, discussions are going on with Dennis Crabtree of the Canadian Astronomical Data Centre (CADC) to utilize their extensive resources for the long-term, on-line archiving of JCMT data and to adopt the STARCAT utility for use at the JCMT. STARCAT is a sophisticated tool for accessing, browsing, previewing, selecting, and manipulating astronomical data, much beyond what we would be able to provide through local efforts alone.

Conceptually the JCMT Archive consists of two parts: a `catalogue' and the `data'. For simplicity, the `catalogue' can be thought of as all the header information associated with the `data', such as source names, positions and telescope configuration.

Figure 1. Figure 1 schematically shows the global design idea as it forms the basis for current developments. This design incorporates input from various discussions with CADC, but there is no official agreement and any real involvement of CADC will be decided upon at the time the local development has progressed to the point where such an involvement becomes relevant. The design consist of three or four components:

Ø the Telescope Management System: this is a RDBMS which runs on a SUN Sparc computer at the summit. Its design is optimized for interacting with the real-time operating system of the telescope and, in addition to astronomical data items, it may archive information which is relevant for hardware monitoring and engineering purposes. A subset of its information will be forwarded automatically to the Archive at the JAC.

Ø the Archive: this RDBMS runs on a SUN Sparc at the JAC and in design will be compatible with the CADC Archive. It will hold all astronomical data on-line during the proprietory period. Besides STARCAT, tools will be provided to extract data into GSD, HDS, or FITS files for authorized users.

Ø CADC: this RDBMS provides the long-term on-line storage. CADC has the hardware resources to provide such service. The idea is that the `catalogue' will be forwarded from the JCMT Archive e.g. every night and the `data' once the proprietory period has expired.

Ø ROE: this is an optional RDBMS which exactly mirrors the JCMT Archive and to which data is automatically forwarded. The necessity for a RDBMS locally in the UK strongly depends on the reliability and the development of bandwidth of the Internet. In principle local RDBMSs could be located at any place deemed necessary, but ROE is an obvious candidate.

The Telescope Management System

In general astronomical observations produce a collection of observation files (e.g. FITS, GSD) which store the actual data but also the information about the hardware configuration of the telescope and e.g. weather conditions. Whereas such a setup is quite acceptable for astronomers, who in general only marginally use all the configuration information, it is highly inconvenient for the scientific staff and engineers who are responsible for the performance of the telescope. The simple task of checking e.g. a receiver temperature over several months requires information to be extracted from a huge number of individual files. Moreover, events at the telescope do not necessarily happen in step with `10-min' observations: the frontend or backend configuration may only change a few times during the night, or some atmospheric conditions one might want to sample on a few seconds time scale.

The TMS differs in setup from such `traditional' astronomical archive in that it can deal with a hierarchy of the different levels of `header' information. The first step is to recognize these levels. This is not too difficult if one realizes that configuration changes at the telescope occur typically for the major hardware components as a whole: the parameters for the secondary mirror change because it is chopped in a different mode, or, the frontend changes because the astronomer changes lines. Hence, the TMS typically has a table for each of the hardware components, so that a change of the telescope configuration may typically result in a new entry in one table only, with the other tables remaining unchanged. In addition the TMS has tables to log the information associated with each scan. Clearly, it is important in this scheme to keep track of which lines of the tables go together to form an observation. Fortunately, this is exactly what the 'relational' of a 'R'DBMS is about. Also, the whole design is something which can be made transparent to the user, who typically will see a single, large table with an entry for each scan.

Figure 2. Figure 2 shows the tables as have been implemented currently to handle DAS data. The tables belong to three categories. The first set (colored gray) stores information associated with each scan, the second set (the wagon wheel on the right) stores overall setup and the telescope configuration information, and the third along the top keeps information administrative information (such as PATT numbers, project titles etc.).

wea#	**utstart**	**utstop**	**tamb**	**pressure**	**humidity**

1	5/5/94 3:15am	5/5/94 3:41am	6.07	627.4	26
2	5/5/94 3:41am	5/5/94 4:03am	5.60	627.5	29
3	5/5/94 4:03am	5/5/94 4:43am	4.04	627.9	31
4	5/5/94 4:43am	5/5/94 8:38am	2.96	627.9	32
5	5/5/94 8:38am	5/5/94 10:17am	1.69	628.7	31
6	5/5/94 10:17am	null	2.28	628.2	29

Table 1.

The centre of all this is formed by the INH table (INtegration Header), which for each scan stores scan-specific header information and indices to entries in many of the other tables. For instance, it uses the index wea# to point to the WEAther table which looks like Table 1.

An index wea# = 3 in the INH table points to an unique entry in the WEA table, and similar for most other tables. For redundancy, the same unique connection can be made using the UT timestamps within each table.

Not to worry, all this complexity is hidden from the normal user, but the above concepts are needed to understand the benefits of the TMS. First of all, it is an efficient method of storing information: the above period of about eight hours during which about 25 DAS scans were taken, resulted in only 6 unique entries in the weather table, because the DB was instructed only to log weather changes exceeding certain limits. Similar, only 4 unique entries appeared in the backend configuration table. Each table changes with a frequency which corresponds with the actual events associated with its real-world component, rather than the number of scan observed.

Secondly, it is a modular setup. Currently all the entries are constructed by reading the DAS GSD files. However, in the future components like the weather, tau, and seeing monitors may write directly to their associated tables in the database. The telescope STORAGE task won't have to deal with those items making it more efficient and hopefully faster. This strategy could be extended to all components that are setup prior the observation and do not change during the observation: e.g. the smu, frontend and backend configurations, focus and pointing parameters. Rather than with the data, the changes can be logged upon setup.

Thirdly, the modular design promotes the adaptability of the database. New tables can quite easily be added to the structure, a situation which may be relevant when e.g. new receivers are added or specific hardware problems need to be tracked down. Existing tables can be modified (columns added or dropped) without having to touch unrelated information.

From this explanation it should be clear that the TMS is designed with the operation of the telescope in mind, rather than the astronomical observations. This is exactly opposite to what is currently happening with archiving to GSD files. It is the hope that the availability of a TMS will significantly improve the performance of and knowledge about the telescope and its equipment. For instance, a tool may be provided to both the observers and TO to check the receiver temperature, since a simply (SQL) statement like:

select ut, trx from TMS where

frontend = `RXC2'

and obsfreq > 489 and obsfreq < 491

and ut > `6/1/1994'

will show the receiver temperature of C2 within the stated frequency range as a function of time since June 1994. And this information will be delivered within seconds.

Having prompt information like this at your fingertips during observing can be very helpful in judging observations and problems. Obviously, for standard applications like the one above the users will have utilities available and won't have to issue the raw SQL statements. By the way, it will be possible for information from the database to be automatically extracted at the end of each scan and written to a GSD file, so that the end result for the observer will look the same whether the STORAGE task or the database is used. However, we imagine that observers will start to find it more convenient to access the data directly from the database, with all the facilities this will provide.

The JCMT Archive

The JCMT Archive will look much more like a traditional observation file. Selected items from the TMS will automatically be combined and forwarded to the JAC as a FITS table. FITS tables are the file format that CADC has adopted and differ from regular FITS files in that they store wavelength-Tk pairs (DAS data) rather than Tk values only. Moreover, multiple sets can exist within a file. In this they very much resemble GSD files and a one-to-one mapping exists between the two file formats. Regular FITS files are not suitable because it is not possible to store the overlapping sections of a DAS spectrum in a single file. In order to go from the FITS tables to FITS files the for most DAS users familiar SPECX DAS-MERGE (and CONCAT) function has to be performed. Although at least for 94B we expect to still keep the GSD files alongside of the DB, I intend to provide tools which flexibly allow data to be extracted from the DB in a number of formats: FITS tables, GSD, and eventually FITS files (which thus implies a DB CONCAT and DAS-MERGE). Also, in collaboration with Rachael Padman we may provide for SPECX to directly read from the DB.

SCUBA data will come in the form of a set of gridded maps for which the FITS standard is much better defined. Likely, these will essentially be stored as regular FITS images and be made available as HDS or FITS files. The data volume of the SCUBA images may be too large to store on-line for timescales longer than the proprietory period. If this is the case, CADC will keep a `preview' version of the image on-line, which has been reduced in volume by a factor of 10-30 through a process of lossy compression. Having inspected the preview image, a request for the actual data will have to be filed and the images will be made available likely through Internet. The details of this a couple of years in the future still, but this is the outline.

Aside from the observations information like dated efficiencies and beam maps will also be made available through the archive.

Irrespective of how and in what format the data are going to be stored in the JCMT Archive, we intend that STARCAT will be available to browse the `catalogue' part and inspect the `data'. On X compatible displays STARCAT uses generally available X tools (Xmosaic, xv, saoimage) to access the archives. Although it was not set up to be very user friendly, during a demo Dennis managed to on-line `baseline' and `bin' IUE spectra in the archive using these general tools only. Hence, it may very well be that users will be able to concat/merge and baseline the spectra before extracting them from the JCMT Archive.

Similar, CADC has pipeline processing (using IRAF) set up on some of their images to do mosaicing and flat-fielding on-line. Among others, STARCAT currently gives access to HST, IRAS, IUE, and CFHT data, as well as a number of `standard' catalogues. STARCAT also has an European counterpart at ESO (ST-ECF) where it is being used and developed for data from the ESO telescopes. In the near future probably all archives will be transparently accessible through either site. For more information on STARCAT, look at its `xmosaic' page at

`http://cadcwww.dao.nrc.ca/CADC-services.html'.

The Catalogue

The `catalogue' part of the JCMT Archive essentially will be the header information associated with the actual astronomical data. In principle this information could become public immediately following the observation, even while the actual data is still proprietory for a year. This raises a concern for those who would like to keep e.g. sources, positions, and maybe observing strategies secret. Obviously a mechanism will be put in place to prevent anybody, but the PATT project members to access the astronomical `data' during the proprietory period. This could be extended to most of the `catalogue' during the same time, but such policy runs counter to the whole philosophy behind the DB effort. Current plans are to make the catalogue publicly available immediately, but to round the positional information to e.g. the nearest degree during the proprietory period.

Database Tools

SYBASE has a Client-Server structure. What this means is that a continuously running Server process (a `daemon') handles requests from user initiated Client processes. Clients connect to the Server and communicate with it essentially using SQL statements, like the examples above, although in general the

SQL part will be hidden from the user. The Server will take care of all the problems associated with accessing the data in a multi-user and distributed environment.

One advantage of this setup is that Clients can be run locally anywhere on the Internet but connect transparently to the Server e.g. at the JAC or CADC. The JCMT has purchased software to be able to build Clients for Suns, VMS hosts, and Dec OS/F hosts, which can be installed at the users institute (which involves a simple copy since they will be statically linked executables). For Sun's we have additional software which enables us to build Forms-based X tools.

Conclusion

I hope that this discussion of the JCMT TMS and Archive has given some idea about the direction the project is taking. Out of necessity I have only touched on many areas and not been able to fully discuss all the issues involved. If you have questions or concerns, feel free to contact me.

Remo Tilanus, JAC

(rpt@jach.hawaii.edu)

JCMT Visiting Observer Accounts

Introduction

When an observer or an observing team comes out to Hawaii for an observing run on the JCMT, an account is needed on the JAC computing systems for use by the team. In the past, we have provided a Guest Account mechanism (the infamous **GUEST00** login on the VAX systems) which allowed each member of an observing team to create an individual, temporary account. When Sun/UNIX systems were added to the JAC computing infrastructure, the Guest Accounts were extended so that a user could work in both the UNIX and VMS environments from the same account. The Guest Account mechanism, however, applied only to the Hilo systems - at the summit, visiting observers typically logged in to the **JCMTUSER** account to reduce their data as it was received. This approach has a number of problems:

ØThe present Guest Account mechanism does not exist at the summit. A coordinated setup, involving all sites (summit, HP, and JAC) and all computers (VAXes, Suns) would be much more elegant and user friendly.

ØThe number of current guest accounts is finite which, at times, created problems.

ØThe **JCMTUSER** password is, necessarily, known to a large group of people worldwide, which is a general security risk.

ØThe **JCMTUSER** account gives access to the current observations for anyone knowing the password.

ØAs the JCMT moves toward a RDBMS-based data archiving system, a need arises for some form of personilised authenticated access to the database while the data is proprietory (1-2 years). While database access does not imply login access, for the convenience of the user and of the Archive Administrator, it is useful for the database id-password pair to at least be based on the original login id-password pair.

Because of these and other problems, a new procedure was needed.

Design

Over the past few months a new procedure has been developed for the assignment of accounts to JCMT Observers. The design goals of this procedure were:

Ø It should be consistent - the observer's login and password should be the same, whether the login is on a Hilo VAX, a JCMT Summit VAX, or any JAC UNIX system (or eventually, the RDBMS Archive).

Ø It should be convenient - once the accounts have been created, any JCMT Telescope Operator or Support Scientist should be able to provide the visiting observer with the correct login id and password.

Ø It should be secure - consistent with the previous item, while it should be easy for authorized staff to have access to the account passwords,it should not be easy for unauthorized persons. Also, one account should not have access to the another account's data.

Ø It should be script-driven: a single command procedure should create the accounts, setup permissions, activation and deactivation dates for all sites on the JACH network. At the start of each semester a list with PATT numbers and observation dates should serve as input for the script.

Implementation

Recently, an Observer Account mechanism has been implemented which is consistent with the design goals as outlined in the previous section.

Observers arriving at the JAC will have a login on any host with as login name their PATT number. A custom utility, only executable by JCMT Staff, can be used to disclose the password for the account. Users who need the password prior to arrival should contact their support scientist.

On the summit computers (MWTRED (VAX) and IEIE (Sun) --- domain: jcmt.jach.hawaii.edu --- the accounts are only activated during a very short period around the observation date (of the order of days). On all other systems --- domain: jach.hawaii.edu --- the accounts will be remain accessible for a period of several weeks after the observations have been completed. Because of this and the fact that the link between the summit and JAC may not be available at certain times, a separate home directory exists at the summit and at the JAC. Observers who wish to continue to work on their data after the observation (i.e. while at the JAC) **must** use FTP or rcp to copy the files to their JAC home directory.

Similar to the current system on MWTRED, the home directories for visitors at the summit are set up as

DISK$USER:[JCMTUSER.OBSERVE.*userid*], which is being automounted by the Sun (/home/*userid*). This scheme allows a user to access data from either the VAX or a Sun: data will be written to the home directory. For users who prefer to use the VAX, nothing much changes. Users who prefer a Sun will have to open a remote DECterm (running on the VAX, displaying on the Sun) to run SPECX, until such time UNIX-SPECX becomes available. However, FITS files created with SPECX can directly be read into CLASS or IRAF, which are both available on the summit Sun. Similar, Sun editors can be used on any of the text files.

In Hilo, the visitors' home directories are automounted from the VAX disk DISK$JCMTDATA:[*userid*]. Note that the Hale Pohaku Sun **MOEMOE** is a Hilo machine for login purposes.

Final notes (by RPT)

The new setup as outlined above may seem rather straightforward and trivial, in fact it is build upon an extensive and complex integration of the underlying computer network at the JAC. Development of this network has been a major achievement of Henry Stilmack and David Fuselier this past year. Remarkably, most of this work has been fully transparent to the users. Every effort will be made to avoid complications while moving to the new Accounts Mechanism, but in case of unexpected problems, we encourage observers not to hesitate in asking JCMT support staff for help.

Henry Stilmack & Remo Tilanus, JAC

JCMT Computer Network

Introduction

The past half year has seen a rapid expansion of UNIX hosts and utilities at the JAC. Sun Sparcs are now available both at the summit as well as HP. Although the VAXes will remain available, we expect that over the course of the next year most of the data reduction will shift towards the Suns. The two most critical programmes SPECX (spectral line) and JCMTDR (continuum) are in the final stages of being ported to Unix. On the long term, the JCMT plans to move its real-time telescope operating system from VMS to UNIX as well.

In this article I briefly want to outline the network setup and (UNIX) utilities available at the JAC. I also want to take the opportunity to solicit suggestions for software you would like to be available while observing.

A general introduction for new UNIX users is available as the document `Introduction to UNIX at JAC' e.g. via the JAC WorldWideWeb server:

(http://jach.hawaii.edu/).

Networks

The local JCMT network consists of two parts: the general JAC Ethernet (jach.hawaii.edu) and the JCMT summit Ethernet (jcmt.jach.hawaii.edu). The general JAC Ethernet *includes* the network at HP. Because the summit is a separate subnet one has to specify the `.jcmt' bit explicitly when trying to access hosts at the summit from Hilo. Thus, use `rlogin mwtred.jcmt' rather than `rlogin mwtred'. From the summit, the network will automatically default to the general net if the host is not found locally.

By the time of this publication all terminal servers will be `dual protocol', hence capable of accepting TCPIP commands. From the server prompt on a VT330 display one can directly connect to any Internet node without having to login to a local host first.

Hosts

A new setup for visitor accounts is being described elsewhere in this newsletter. The following table lists the hosts currently available to visitors:

JAC (jach.hawaii.edu):

ulu	(bread fruit)	Sun Classic
hala	(screw pine)	Sun LX
kala	(the sun)	Sun IPX
kaua	(the rain)	Sun LX
makamakahiki		Sun LX
menehune	(hawaiian troll)	Sun 20/502 (DB server)
maile	(fragrant flower)	Sun LX
malama	(server)	SUN 20/61 (UNIX server)
awa	(hawaiian drug plant)	Dec Alpha (Unix)
maikai	(strong)	VAX 4000/60
kekoa	(koa tree)	VAX 4000/60
nahoku	(stars)	VAX 3500
kealii	(ohia flower)	VAX 4000/60 (VAX server)

HP (jach.hawaii.edu):

moemoe	(sleep)	Sun LX

(two X-terminals)

JCMT (jcmt.jach.hawaii.edu):

ieie	(highland vine)	Sun LX (DB server)
mwtred		VAX 4000/60

Printers and Tape Drives

HP LaserJet printers are available at the summit, in Hilo and at Hale Pohaku. All of these printers can accept postscript as well as ASCII format. It is possible to print across the network from a machine at any site to the printers at the other sites. For more details, including queue names, see JAC User Note 6.1.

Exabyte and DAT tape drives are available at JCMT and in Hilo, and a DAT at Hale Pohaku. The Exabyte at JCMT is low-density format (max 2.3 Gbytes on a 90m tape). The DAT at JCMT is primarily for use in making system backups -- if you want to use it, the TO should be able to help. The DAT drive at Hale Pohaku is on a SPARCstation. To use this drive for archiving VAX data, please contact a member of the Computing Services Group.

Reduction Software

A number of astronomical data reduction packages are available on the SUNs, in addition to the familiar ones on the VAXes. Although we have tried to be thorough during the installation, many packages have seen little use at this time and users should not be surprised if some more feedback will be needed to get all bells and whistles in place properly.

(J: installed at JAC only, not available on summit computers)

Astronomical Data reduction:

STARLINK	- All SOLARIS Starlink utilities
SPECX	- (expected in near future)
CLASS	- IRAM single-dish data reduction package
CFITS	- IRAM fits-to-class file conversion
GAG	- IRAM GAG utilities:

GreGPLOT, astro, cfits, class, gag_ps_header.ps,
gagdef.bin, gagplot, gfits, graphic, greg, gregfont.bin,
grfont.dat, gtvdef, lwxy, overlay, vector

```
IRAF            - NOAO IRAF

AIPS  (J)       - NRAO data reduction package

MIRIAD  (J)     - BIMA reduction package

GIPSY     (J)   - Groningen Image Processing SYstem
```

Plotting:

```
wip             - Mongo like interactive PGPLOT

sm              - SM (a.k.a. Super Mongo) interactive plot facility

pgdisp          - PGPLOT X-windows display (pgplot device: \xdisp)
```

Utilities:

```
schedule   (J)  - Displays JCMT SCHEDULE (jcmt.jach.hawaii.edu only)

vehicle - Displays VEHICLE schedule on VAX
```

Unix shells:

```
csh             - C-shell

tcsh            - Enhanced C-shell

sh              - Bourne shell

ksh             - (Korn) Enhanced Bourne shell

bash            - Bourne again shell
```

Window Managers:

```
olwm    - Open Look window manager for OpenWindows

olvwm   - Open Look virtual window manager, also for X11

twm     - Tab Windows Manager for X11

tvtwm   - Virtual Tab Windows Manager for X11
```

Editors:

```
emacs           - GNU emacs

vi              - as usual

jed             - Starlink EDT emulation
```

Remo Tilanus, JAC

Nine-Track Tape Drives

In the next few months, JAC will be phasing out support for nine-track tapes. The tape-drive at the JCMT is no longer on maintenance and will soon be removed; the drives in Hilo will probably be removed by the Fall. By far the best method for observers to take away their data is via FTP; although Exabyte and DAT tape drives are available at the summit and in Hilo. We would very much prefer observers to bring their own tapes with them if possible. If we supply you with a tape, the cost will be added to your bill. If any observers have left their own nine- track tapes in Hilo, they should make arrangements to copy their data to a different format.

Richard Prestage, JAC

SPECX Notes

Horst Meyerdierks, at Edinburgh, has now made an interim release to Starlink of SPECX V6.4 (for Unix). This version has no support for GSD files (as produced by the JCMT), and, as the Starlink beta-testers have found, requires a certain amount of jiggery-pokery to translate map files produced on VMS machines. An even more recent version produced at Cambridge *does* provide support for GSD files (using Remo Tilanus' C-interface to GSD), as well as fixing a few of the bugs produced in the port. Discussions are now under way on the best way to make VMS-style maps directly available, and the next Unix release has been delayed until this issue is resolved satisfactorily. It is still possible that this fully-functional release will leapfrog the one currently in the pipeline. My thanks to Horst Meyerdierks for all his hard work on the Unix port.

The Unix version has now been ported back to OpenVMS V6.1, and is running on an Alpha at MRAO. VMS Specx V6.4 retains the full functionality of V6.3. At the next release (V7?) we hope to bring all three versions - Unix, VAX/VMS and Alpha/VMS - into line, and possibly to include support for NDF files in the VMS versions. Meanwhile, Starlink are providing the interim release in time for the deadline of 1 December 1994, when all Starlink VAXs are to be turned off. Because of this deadline, and the differences between the various flavours of Unix, there will be no support in this version for last-line editing, or for CTRL(C) trapping. It is possible that these will be reinstated in a subsequent release.

Unix SPECX includes calls to many Starlink libraries. Distribution to non-Starlink sites will therefore not be entirely straightforward, and details still have to be resolved with the Starlink management. Starlink should be able to supply either `built' versions, including binaries, for particular machines, or alternatively to supply the full source and makefiles for both Specx and the relevant libraries. Conversely, given that Starlink is no longer going to support VMS-based software, we will probably arrange for the VAX and Alpha versions to be available via anonymous ftp from MRAO.

MERGE and CONCAT

Several people have been observing very wide lines (in distant radiogalaxies for example) by taking two or more spectra with different centre frequencies, and then trying to knit them together into a single spectrum using CONCAT followed by MERGE. The results tend to be variable, and depend on exactly how you achieve the different observing frequencies. One superficially attractive way to do it, which will *not* work, is to change just the nominal vlsr of the source.

The basic problem is that the SPECX header only stores *one* set of velocity information (all velocities are for the start time of the observation). That is:

* **vte:** velocity of telescope *wrt* earth.

* **ves:** velocity of earth *wrt* sun.

* **vsl:** velocity of sun *wrt* lsr.

* **vlsr:** velocity of lsr *wrt* source.

If your data have different values of VLSR in the two spectra (and slightly different values of vte, ves and vsl), then when you CONCAT, you lose one set. The spectrum that loses its header is no longer properly calibrated in frequency. SPECX - or at least the MERGE routine - takes its cue from the value of F_CEN, and since this is corrected to the source frame it is (almost) the same for both spectra. So once you throw away VLSR it looks as though the spectra have almost the same centre frequencies: MERGE then sorts them according to the very small residual difference.

There is a reason for MERGE working this way. It was originally conceived as a way of putting together spectra taken at the *same* time, for which the routine would necessarily work correctly by comparing true frequencies (i.e. in the telluric frame). For this particular case you have exactly the same telluric (i.e. i.f.) frequencies, and MERGE knows that.

Now, since a NEW-PLOT of the concatenated spectrum does come out right, you can see that the information *is* still available (these days): it is obtained from a combination of if_freq, lo_freq and rest_freq, all of which are stored on a per-quadrant basis. So in principle we should be able to use these to decide how to do the MERGE. But there is a fundamental problem in that *now* MERGE (in reducing many quadrants to one) will instead be throwing away *other* information, such as the LO frequency. Different bits of the spectrum will then still be incorrectly described by the header. The apparently straightforward MERGE process necessarily produces a spectrum which is now calibrated for only one frame, and any attempt to display it in another frame leads to an erroneous frequency scale.

I have therefore disabled CONCAT for spectra which have different VLSRs. One way to get around this is illustrated in the SPECX macro *concat.spx*, which is available by anonymous ftp from *mraos.ra.phy.cam.ac.uk*, in directory */pub/rachael*. This works pretty well as long as the spectra being concatenated and merged were taken relatively close together in time, and could be a basis for something more sophisticated if you so desired.

Remember that as long as you *don't* MERGE, the display should be OK, since you have enough frequency information in the quadrant headers to override the velocity information. But if you do decide to merge the two spectra, then caveat emptor.

Rachael Padman, MRAO Cambridge

rachael@mrao.cam.ac.uk

Why are my Lines coming out the Wrong Intensity?

Several observers have been finding that the brightness of spectral lines from the heterodyne receivers are not constant. Sometimes they are not the same as a year ago, and sometimes they vary from night to night. In late 1993, the calibration appeared to be much worse than normal. This was traced to specific faults with both RxB3i and RxC2; observers with data taken at this time should be aware of these faults.

In both cases the problems in late 1993 were eventually traced to standing waves within the receiver dewars. With RxB3i, this was a result of a fluorogold covering over the quartz thermal blocking filter becoming detached. The problem with RxC2 was caused by a layer of polythene on a similar quartz filter peeling off. It is believed to be just coincidence (or Murphy's Law) that both faults occurred around the same time. The standing waves resulted in receiver temperatures and sideband ratios which were highly frequency dependent. The overall receiver performances were also worse than normal, and there was some small variation with elevation.

The problem with RxB3i was noticed in October-November and can now be traced back to the warmup at the end of July 1993. At frequencies around 345 GHz there were sometimes variations of approximately ±30% in the final line calibration. These were somewhat less (15%) at higher frequencies (around 360 GHz). The filter was fixed during a period when the receiver was not required in early February 1994.

Again hindsight suggests that the problem with RxC2 started after a cold head failure in mid October 1993. We estimate the calibration uncertainty after this was approximately ±20% at 460 and 490 GHz. The problem was diagnosed and fixed in mid April 1994.

Even if no specific faults exist in a receiver, there are many other possible sources of error in the line intensities. Below I list some of the more significant, with estimates of their values.

Factors affecting line intensities.

1) Sky variations. Mainly caused by changes between the time of the calibration and the sample. This is negligible under good conditions; test measurements on a source with repeated calibrations and integrations with a stable sky gave ~3% variation with RxA2 and ~6% with RxB3i. Under variable sky conditions (not necessarily correlated with poor sky transmission) this effect can introduce factors of 2 variation in the line brightness. Some work will be done in the Autumn to improve this by using the reference position in each sample as the `sky' for the calibraton.

2) Baselines. For linear baselines, the signal:noise ratio in the integrated line intensity is decreased by the ratio of [linewidth(MHz)]/[baseline(MHz)]. For example, a s:n of 5-sigma in Ta*.dv will be reduced to 3.3-sigma if the line covers 60% of the useful IF passband. This will obviously be worse for higher-order polynomial baselines. Larger s:n is better. No baseline subtraction is also better (ie BMSW).

3) Standing waves. These could be off the windows or filters in the receiver (even when working properly, there will always be some reflection; the filters in RxA2 were intact, yet low-level standing waves have been seen). Signals will also reflect off the hot load, mixer and the secondary. The level can be estimated by observing continuum sources, and variations of as much as 5% can be seen.

4) Beam size. These are measured in the case of RxA2 and RxB3i to typically better than 2%, although note that there is some variation with wavelength. This would result in ~4% error in the line brightness for a point source, although an extended source would show no change.

5) Beam efficiency. For RxB3i, this is known to an accuracy of ±7% at present, although with more measurements we should reduce this below 5%. The RxA2 value is more accurately known, and RxC2 is more uncertain (±10%).

6) Sidelobes. The integrated emission over the inner sidelobes becomes significant at higher frequencies when the accuracy of the dish surface is low. For extended sources, this provides a significant uncertainty. At 690 GHz, this may contribute 50%, and even at 490 GHz, there may be ~10% error . This can be corrected by careful measurement of the coupling to compact and extended planets. It causes an excess in Ta*.

7) Receiver sideband ratio. This is around 1.05 for RxB3i, requiring a correction of ±2.5% to either sideband. RxC2 and RxA2 have values of ~1.1; check with the recent measurements at JACH.

8) Receiver tuning reliability. I repeatedly retuned and integrated on the same line under good conditions using the prescribed tuning technique. Variations of less than 5% with RxB3i and 3% with RxA2 were seen, although these variations may actually have been caused by (1) above.

9) Pointing. This can be significant; eg for a compact source, a 16% decrease in line intensity can be introduced if you're only 1/4-beam off source (that's only 3 arcsec with RxC2).

10) Focussing. This is usually most important around sunset or sunrise when the telescope temperature is changing. An error of 0.5 mm in z will give a ~10% error in the intensity of a compact source at 345

GHz.

11) Errors in the atmospheric model. This is used to determine the sky transmission in the two sidebands, so errors will be largest when the ratio of transmission (a) is largest. It is difficult to quantify the possible error, but tests with RxC2 at 460 GHz (worst case) over a range of a show less than 10% error. It is probably under 3% at say 345 or 230 GHz, where a is close to unity.

12) Telluric Ozone or CO lines. These are not in the atmospheric model, but are taken out, to first order, with the DAS channel-by-channel calibration. The lines are not bright, so this effect is negligible.

13) Variation in physical temperature of hot load. This could change by up to approximately ±5K, resulting in less than 2% error in Tsys. RxC2 and all future receivers will monitor the load physical temperatures.

14) DAS sampler non-linearity. Improvements to the DAS have reduced this down to a level of ±1%.

15) Emission in reference beam.

16) Not enough signal:noise in the line (!).

With the above list, it might appear that you stand no chance of ever getting calibrated data. But it's not as bad as all that. Under good conditions, and assuming you're pointed and focussed etc, the errors combine to a total of ±10% with RxA2 and RxB3i, and ±15% with RxC2 (these are 1-sigma assuming the errors add in quadrature). For a point source, the predicted uncertainties are ~3% larger.

We have been collecting standard spectra from known sources over the last few months, using data from PATT observers, and from E &C time. These data therefore represent a normal range of observing conditions. Analysis of the results so far indicate rms deviations of ~6-12% with RxA2, 6-11% with RxB3i and 10-15% with RxC2.

Standard Spectra.

All spectral line standards are kept as hardcopies and are available on-line on the JCMT summit computer. Summaries of the spectra (both hardcopies and the ones on-line) are found in:-

DISK$USER:[JCMTUSER.REF_SPECTRA.**]

README_**.TXT

and listings of the on-line spectra are found in:-

DISK$USER:[JCMTUSER.REF_SPECTRA.**]

DIR.LIST

where ** is either A2, B3i or C2.

The data themselves are available in specx files within separate receiver subdirectories, and the filenames are of the form: SOURCE_TRANSITION.DAT

I would recommend that whenever one of the JCMT standard line sources is used for pointing (all of them are in the pointing catalogue) a standard spectrum is taken and compared with the on-line data. Once the spectrum has been observed, it can be logged using the command LOGSPEC from ICL. All logged data will be reduced at a later date by local staff. This serves not only as a check of the system operation before the start of observing, but also adds to our database of standard spectra.

Bill Dent, JAC

JCMT Documentation - a Primer

A number of information sources are available to the user of the JCMT, to help in the preparation of proposals, in the planning and execution of observing, and in subsequent analysis. By definition, documentation is never complete or fully up-to-date. For this reason I welcome and encourage a dynamic interaction with the user community on any aspects of existing material; this can only help to improve our information services. Also, in the fairly near term we will making much more use of electronic media, and there will be a corresponding decrease in the emphasis on the printed page.

At present the main sources of information for the user are:

1. A guide for intending users of the JCMT, titled "The James Clerk Maxwell Telescope; a Guide for the Prospective User". For most purposes this is referred to as the `User Guide'.
2. A manual of detailed information on observing techniques, equipment, and data reduction, called the "Astronomer's Reference Manual". You will not need this until you have been granted time or have data from the JCMT.
3. An e-mail fileserver, containing information on all aspects related to the JCMT, including proposal deadlines, equipment sensitivities, and news items of interest to the observer, potential or actual.
4. The JCMT Newsletter acts as a forum for the transmission of news regarding developments at the JCMT, as well as a source of examples of recent research carried out with the telescope.
5. the JAC and at the JCMT printed copies of manuals concerned with specific data reduction packages (such as SPECX and CLASS), and other major utilities, are provided for detailed information on site.
6. Archival information (such as beam maps - see Goeran Sandell's note in this Newsletter) is beginning to be made available by anonymous FTP from the JAC computer system.

7. A series of single-page `fact sheets' on individual receivers and aspects of the telescope have been prepared, and will be maintained as current as possible.
8. There is also a three-volume Telescope Operator's manual and a collection of `MT' notes, both of which are more technical and detailed in general, but which may on occasion be worth consulting.
9. Other sources of user information, such as the data archive, are outside the scope of this note, and are described elsewhere in this and previous Newsletters.

Note: the e-mail fileserver has been discontinued. Please consult the top of the spectral line observing page on how to obtain a copy of the user guide

For the moment, the e-mail fileserver is our most complete information medium. It was described in the August 1993 issue of the JCMT Newsletter. Much of the information contained in it can also be found in printed form. Information can be retrieved from this system by sending short one-line commands by e-mail to it. The simplest way of getting acquainted with this system is to send the one-line message

help

to JCMT_INFO@JACH.HAWAII.EDU. A couple of files will be sent by return e-mail to you, one a `transaction log', which can be discarded, and the other a text file describing the fileserver.

The User's Guide is available in several forms. Printed copies may be obtained through the offices of the partner countries, or from the Joint Astronomy Centre in Hilo, Hawaii. If you send me an e-mail, I will arrange to send you a copy. Also, if you happen to be in Hilo, usually it is possible just to pick one up. The User Guide can also be obtained by e-mail through the fileserver, by sending it the message

send userguide.ps

There are two things to know about the version of the User's Guide you will receive in return. (a) it is in Postscript format (designed for North American paper format), so that you will need to have a compatible printer at your end, and (b) the VMS file size is about 13,000 blocks, so you will need to have a fair amount of disk space free. For the first time, beginning with the 1 August 1994 version, the User Guide comes with all figures embedded in the file. This is the reason for both the size and format of the Guide. Finally, the User's Guide can be browsed on the World-Wide Web by starting at the JAC home page

(http://jach.hawaii.edu/).

For a brief while (until I catch up with it), the version available by this means will be somewhat older than the most recent issue.

A simplified (ASCII) version of the User's Guide can be found in the fileserver; ask for file `receivers.summary'.

The Astronomer's Reference Manual presently comes in eight major sections, and is too large to economically distribute by regular mail. It is presently available only at the JCMT, at Hale Pohaku, and in Hilo. I am currently overhauling all of the sections with a view to making a new base version. This version should be ready for use by 1 September 1994. It is then my intention to provide `roving' numbered copies which will be loaned to visiting observing teams for the duration of their stay in Hawaii, as well as `static' copies, which will be based at each of the sites. This base version will be made available on the fileserver (as separate parts) as soon as time permits, and subsequently on the World-Wide Web. The latter is the ultimate goal, but since it involves an enormous amount of work, it cannot take place overnight. A sensible estimate of the date for this is 1 April 1995. In the meantime, I want to encourage all visiting observers (and local staff) to scribble comments, corrections, and additions on the `roving' copies; as such remarks are returned to me I will use them to improve the manual, with the intention to fully update the set once every six months approximately.

The Astronomer's Manual consists of sections describing (1) the logistics of coming to Hawaii to observe with the JCMT, (2) a quick-start set of procedures for observing, and fundamental concepts, (3) continuum photometry (mostly, but not exclusively, with UKT14), (4) continuum map-making and data reduction, (5) spectral line instrumentation and observing techniques, (6) spectral line data reduction, (7) utilities and facilities available to the user, and (8) the JAC computer network, VMS, and other basic aspects. There are separate manuals detailing the data reduction packages and utilities offered to the user, but these tend to be indigestible for the infrequent or first-time user, and for this reason short `cookbook' descriptions are being included as part of the relevant sections of the Astronomer's Manual.

The Telescope Operator's Manual is primarily for the benefit of the TO's, naturally, and as such it contains operational procedures ranging from safety issues through detailed instructions on the secondary mirror unit to an introduction to SPECX. However, there is intentional overlap between these volumes and the Astronomer's Reference Manual; it is in our interest, and yours, that the TO's can be helpful in the observing process itself as well as in its execution. As a group the TO's have the responsibility to see that their manuals are up-to-date and effective; areas where they feel improvements are necessary (most at present) are communicated to myself and Chris Purton (as their supervisor) for further action. For the moment there is no move to provide electronic versions of the TO's manuals; however, I will be considering this question next year once we have made significant progress with the material to be placed on the World-Wide Web.

Finally, we have a large number of other sources of information which exist separately from the above manuals and computer files. In addition to the self-contained manuals on data reduction and so forth, there are many engineering, hardware, and software documents of greater or lesser utility to the user and to local staff. We are beginning to work on ways to rationalize these within the overall scheme of documentation, with the primary goal being that of effectively meeting the various needs of the JCMT observing community and the local staff.

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JCMTDR Notes

JCMTDR's VAX version 1.0 has been ported to Unix and is about to be submitted to Starlink for release as version 1.1. Following are the differences in the Unix version:

So far it is common to run the commands from the Unix shell. To start up JCMTDR from the shell you need to have the following lines in your `.cshrc' and `.login' respectively:

source /star/etc/cshrc

source /star/etc/login

Then the command

% jcmtdr

will define all the commands of the JCMTDR package.

On-line help is available, from the Unix shell use `jcmt_help'. Alas, the help library is identical to the one on the VAX, so part of it may not be applicable.

GSD format is currently not supported. Thus `makemap', `gsd_print' and `gsd_format' are not available. You will have to process GSD data on a VAX with JCMTDR 1.0.

JCMTDR data are in Figaro/NDF format and can be transferred as binary files between VMS and various Unix flavours. It is not necessary to process the files. However, you might run the `native' command from the Kappa package on the files on the destination machine. This may save some time in further access to the file.

Horst Meyerdierks,

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Beam Maps

Beam maps are a vital tool for characterizing a telescope. They provide information about the optics of the telescope and receivers, and especially at high frequencies they are very sensitive to changes in the surface accuracy of the dish, both as a function of elevation and time, because for a telescope like JCMT we have constantly tried to improve the surface accuracy. For continuum mapping in the sub-mm beam maps of a planet are often necessary, if one wants to accurately calibrate the data. Sub-mm seeing (refraction) can often substantially broaden the beam resulting in large calibration errors if one does not take a beam map of a planet under similar conditions. In day time, when the telescope heats up, the thermal expansion introduces spherical aberration, which significantly broadens the in-focus beams and results in rather large error lobes in the antenna beam pattern.

The main source for beam maps has been from the work done in engineering and commissioning runs as well as my own PATT runs, but I have also searched through PATT runs to find additional maps. The archive is by no means complete, and work is still ongoing to supply additional maps, but at 800 and 450 mm it gives a reasonable review of the history of the telescope.

THE BEAM MAP ARCHIVE IS NOW AVAILABLE THROUGH ANONYMOUS FTP.

This is what you need to do to find out current beam sizes for JCMT or to retrieve a beam map:

FTP>connect jach.hawaii.edu

FTP>login anonymous

give your full e-mail address as password

Once you are logged on to JCMT, set the directory to pub/jcmt/beams, i.e. **cd pub/jcmt/beams** and a .message file will automatically display additional information. If the file scrolls over your screen too fast just copy it over to your own directory by the command `get .message'.

In the beams directory you will also find a JCMT INTERNAL REPORT, which describes the beam map archive, both as a latex file as well as a postscript file (beam_maps.tex, beam_maps.ps)

The actual beam maps reside in subdirectories below the beams directory. Currently you will find the following subdirectories: rxa2, rxb3i, and rxc2 (which contain beam maps obtained with our common user heterodyne receivers), as well as 2000, 1300, 1100, 850, 800, 750, 450 and 350 (which contain beam maps for the diffraction limited beams of UKT14 below 1.1 mm). The name convention here is the nominal filter wavelength expressed in microns. In addition we also have beam map directories for fully open and intermediate apertures for UKT14 for wavelengths shorter than 1.1 mm. These are named 850_65, 800_65, 750_65, 450_65, 350_65, 450_47, 350_47, 450_35, 350_35 etc. Each sub-directory contains a .message file, which is automatically displayed when you go into the directory. For example pub/jcmt/beams/450 contains diffraction limited (27 mm aperture) beam maps obtained with UKT14 as well as an index that characterises each beam map. This index is stored in the .message file. For directories which contains a lot of maps, it is clearly easiest to just copy over the .message file, because this may contain all the information you really want to know.

Goeran Sandell, JAC

SCIENCE HIGHLIGHTS

Submillimetre polarimetric mapping of DR21 and NGC7538-IRS11: tracing the

circumstellar magnetic

The role of magnetic fields in both the initial collapse of molecular clouds to form protostars and their subsequent evolution to the main-squence via the outflow phase, is still unclear. Gravitational collapse may follow the magnetic field lines of the parent molecular cloud, producing a flattened, slowly rotating core, which will continue to collapse as turbulent and magnetic support is lost due to ambipolar diffusion (e.g. Shu, Adams & Lizano 1987). If this is the case, one might expect a correlation between the outflow axis and the magnetic field lines of the parent molecular cloud. Observational evidence imply this may well be the case (e.g. Strom & Strom 1987; Hodapp 1990).

The importance of magnetic fields has been incorporated into several recent outflow models. Pudritz & Norman (1983,1986) have proposed that bipolar outflows are centrifugally driven hydromagnetic winds that originate in the envelopes of rotating magnetised discs around protostars. The disc envelope pressure is maintained by constant flux loss from the dense core due to ambipolar diffusion. This model produces a poloidal magnetic field in the shape of an `hour glass', that co-rotates with the disc. Alternatively, Uchida & Shibata (1985) have proposed that mass is accelerated in the relaxing magnetic twist, created by the wind-up of the magnetic field in the contracting and rotating circumstellar disc. The magnetic field of the disc is coupled to the helical field lines of the parent molecular cloud. The mass outflow follows the field lines (leaving a hollow interior) and gradually accelerates with distance. Unlike the Pudritz & Norman model, the field close to the protostar is toroidal (rather than poloidal). Therefore, the ability to measure the magnetic field direction in the vicinity of outflow sources may reveal the relationship between the disk magnetic field and that of the parent molecular cloud. This should provide direct evidence for or against each of the hydromagnetic wind models.

As optical, near and mid-infrared polarization can be produced by either scattering, dichroic absorption or dichroic emission of radiation, any information deduced from observations about the magnetic fields close to protostars is highly uncertain as they require the `disentangling' of the polarizing effects. The most direct, and therefore potentially most reliable technique for mapping these magnetic fields, is to observe the polarised emission from warm dust in the far-infrared or sub-millimetre. Observations at such long wavelengths have the advantage of being free from contamination by scattered radiation. The position angle of polarization for dust emission is parallel to the long axis of the dust grain, and therefore perpendicular to the magnetic field, assuming the dust grain is aligned by paramagnetic relaxation (Davis & Greenstein 1951).

We report the detection of 800 mm polarization at the flux peak and positions around the outflow sources DR21 and NGC7538-IRS11 (referred to as IRS11 throughout the rest of the paper). The observations were made using the Aberdeen/QMW polarimeter in conjunction with the continuum receiver UKT14. The data acquisition modes and data analysis methods used with the polarimeter are described elsewhere (Murray 1991; Minchin & Murray 1994).

The polarimetric data for both DR21 and IRS11 are presented in Table 1 and shown graphically in Figs.

1 and 2, respectively. For both sources the direction of the polarization vectors is extremely uniform and the dispersion is small. This implies that, within the reslution of our observations, the magnetic field is both uniform in direction and strong. If this were not so disruptive processes would affect the grain alignment, reducing the uniformity of the observed polarization position angles (Chandrasekhar & Fermi 1953).

The direction of the magnetic field around DR21 is not aligned with either the direction of the outflow axis or the major axis of the submm circumstellar dust structure. As the DR21 region is extremely complex, possibly containing 3 outflows in close proximity, the non-alignment may not be significant.

For NGC7538-IRS11 the magnetic field is aligned with the outflow axis, implying that *within the resolution of our observations* (14 arcsec FWHM) the circumstellar magnetic field is poloidal. The direction of the molecular outflows, magnetic fields and dust ridges for both IRS11 and its neighbour IRS1 (60 arcsec/0.9 parsec to the north) are in identical directions. As IRS1 and IRS11 are linked by an arm of submm emission and form an elongated dust ridge that is orthogonal to the ambient magnetic field of the NGC7538 region, part of the cloud may have collapsed along the magnetic field lines to produce the core from which IRS1 and IRS11 have formed.

There is a marked increase in the observed percentage polarization from DR21 at higher wavelengths (1100 mm and 1300 mm). This implies the grain composition cannot be predominantly silicate, but instead is mainly graphite/metallic, and may require grains of different magnetic susceptibility or varying elongation to also be at different temperatures along the observed line of sight.

Position Number	**RA(") Offset**	**Dec(") Offset**	**P (%)**	**Theta (degrees)**
DR21				
1	0	0	1.8 ± 0.3	17 ± 4
2	7	0	2.1 ± 0.5	29 ± 7
3	7	7	3.0 ± 0.5	15 ± 6
4	0	7	2.7 ± 0.4	20 ± 5
5	-7	7	2.4 ± 0.3	30 ± 4
6	-7	0	1.7 ± 0.3	34 ± 5
7	-7	-7	2.5 ± 0.4	30 ± 5
8	0	-7	1.9 ± 0.8	23 ± 11
9	7	-7	2.2 ± 0.5	35 ± 7
10	0	14	2.6 ± 0.6	23 ± 6
11	0	-14	2.0 ± 0.9	30 ± 12

NGC7538 IRS11

1	0	0	2.5 ± 0.2	58 ± 2
2	7	0	4.0 ± 0.4	66 ± 3
3	7	7	3.7 ± 0.6	56 ± 5
4	0	7	3.4 ± 0.3	57 ± 3
5	-7	0	2.6 ± 0.5	64 ± 6
6	0	14	5.6 ± 0.9	49 ± 4

Table 1: 800 mm polarimetric observations

The percentage polarization at the position of the flux peak for each outflow source is low compared to the offset positions. This has been noted for several other outflow sources and is commonly referred to as a polarization `hole'. It is unlikely that either the effect of flux contamination by unpolarized line emission or reduced grain alignment/changes in the grain size distribution or composition could be responsible. The most plausible explanation is a change in the magnetic field alignment in the vicinity of the outflow source. Poloidal magnetic field lines may become directed closer to the observers line of sight in the vicinity of the outflow source, or the magnetic field lines close to the outflow source may become twisted, possibly due to the presence of a toroidal field in a circumstellar disc.

This is a summarised version of a paper to be published shortly in Astronomy & Astrophysics (Minchin & Murray 1994).

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Detection of [C I] 492 GHz emission from a high latitude translucent cloud

Translucent clouds are clouds with Av = 1-5 mag which lie in the chemically interesting region where carbon is transformed from atomic to molecular form, C+ -> C -> CO. With the advent of sensitive SIS receivers at 492 GHz such as RxC2. it is now possible to search for the weak [C I] 3P1 -> 3P0 line from translucent clouds in order to test the models. Stark and van Dishoeck (both from Leiden Observatory) detected the [C I] 492 GHz line in the well- characterized high latitude translucent cloud towards HD 210121 (see figure 1). The measured line strengths TMB vary from <0.6 to 1.6 K, and are more than an order of magnitude weaker than the [C I] line commonly detected in dense photon-dominated regions (PDRs). Also, the derived abundance ratio C/CO = 6-7 in this cloud is significantly larger than the ratio C/CO = 0.1 found in dense PDRs. Such a high ratio is consistent with models in which not all carbon has yet been converted into molecular form. From the observed line strengths, it is concluded that the [C I] 492 GHz line plays a non-negligible role in the cooling of translucent clouds. Its cooling is found to be larger than that of CO, and comparable to that by [C II] 158 mm emission within a factor of a few in this cold cloud.

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JCMT observations of the Comet Shoemaker-Levy 9 collision with Jupiter

As everyone now knows, the collision of comet Shoemaker-Levy 9 with Jupiter did not bring about the end of the world (although the first impact occurred just 24 hours before the start of the World Cup final, which Italy lost - so there may have been some validity to claims that it would portend some sort of human catastrophe). But, while failing to live up to the expectations of mad prophets, the event surpassed those of the countless astronomers who prepared to observe it with just about every major astronomical facility in the world. At the JCMT, the 10-day encounter was observed by a large consortium of UK, Canadian, US and French astronomers.

In the atmospheres of the giant planets, spectral lines can arise either due to emission in the stratosphere producing narrow lines (typically 20 MHz wide), or due to absorption in the troposphere against the background thermal emission from the planet's interior, producing strongly pressure broadened absorption lines (typically 10 GHz wide). Our aims were to use the JCMT heterodyne receivers to search for possible stratospheric emission lines, and the University of Lethbridge Fourier

Transform Spectrometer (FTS) to look for the much broader tropospheric absorption features. Prior to the run, no near-millimetre spectral features had been observed from Jupiter in its normal condition. We were awarded 11 JCMT shifts, covering the period of bombardment and a couple of days on either side.

Our initial expectations were, frankly, not very high. We were concerned that any anomalous spectral structure from the small impact sites might be at a very low level, and could be swamped by the enormous continuum from Jupiter, which we could not avoid with the relatively crude angular resolution of a mm/submm telescope. Moreover, fluctuations due to tracking errors could lead to varying and non-linear baselines, preventing any lines from being detected. In addition, providence had decreed that Jupiter would only be observable from around 3.30-10.30pm each day, which includes a large chunk of afternoon time when the atmospheric noise is usually at its worst. Finally, we were also afraid that the weather would be bad throughout the run; only in this respect were we completely right.

Line observations:

For line observations, we adopted an observing procedure of beam-switching 60" at 4 Hz, and alternating between the impact site on the southern hemisphere and a corresponding reference point on the northern hemisphere. Not knowing what molecules to look for, we chose CO, HCN and H2S as likely candidates. Observations using receiver B3i in the two days preceding the first collision showed no evidence of emission from either hemisphere.

The first impact (A) occurred at 9.30am on July 16th, and the second (B) at 4.50pm on the same day - during the observing shift. We looked at both sites in the HCN 4-3 line (354 GHz), and saw nothing, even though we caught B as it rotated into view just after the event and tracked on it for over an hour. Undeterred, we set up to observe the site of impact C in the same line. The impact occurred at 9.07pm, and the site became visible about 20 minutes later. We carried out a cycle of integrations on site C and its reference position over 20 minutes, and this time we were rewarded with a clear detection of the HCN 4-3 line with an antenna temperature of about 1 K and a FWHM of 8-10 km/s (see Figure 1). Subsequent observations did not result in a confirmation of the detection, but Jupiter was setting and the system temperature rapidly increasing. So at that stage we were not able to say whether or not the effect was short-lived.

On the following night, July 17th, we succeeded in detecting HCN 4-3 from the 3.5-hour old impact F site. We looked at the position of F in CO 3-2, but did not detect anything to a noise level of 150 mK with TBD km/s resolution. We were looking forward to catching the biggest collision of them all, impact G, due to occur at 9.30pm; but then it started to rain.

On the 18th, we managed to observe G (now 21 hrs old), detecting a very strong HCN 4-3 line (see Figure 2). We also detected the 12-hour old H impact in the same line. So it was clear that the HCN was persisting for at least a time on the order of 1 day, but the rate of decline of the signal from a single impact site was yet to be measured.

For the next few days, the weather was generally miserable as hurricane Emilia and tropical depression Fabio passed by to the south of the Big Island. Nevertheless, we observed when we could, and confirmed HCN 4-3 at various other positions. Impact sites were now piling up to such an extent that several sites were usually contained within our 14" beam, making it difficult to tell which siteswere dominating the emission. We also used receiver A2 to make two measurements of the HCN 3-2 (266 GHz) line on the position of impact R, 48 hrs apart (see Figure 3).

At the time of writing (July 24th - our last night), all the impacts have occurred, and attempts to get follow-up data on previous measurements and monitor variability have been largely prevented by bad weather.

FTS observations:

Although the FTS is ideally suited to the detection of broad tropospheric absorption features, observations proved very difficult due to the unstable atmospheric conditions. The line receivers were given precedence whenever the weather was poor, which was most of the time. On one occasion, at the precise moment when the FTS was fired up and ready to take over from the line receivers, tropical depression Fabio reached the summit and the telescope shut down for the remainder of the shift. As a result of the generally poor conditions, only a few results were obtained.

The observing strategy for the FTS component of the run was to point at the central meridian of the planet, offset towards the south pole to observe the impact sites rotating through the field of view at -44 degrees S latitude. An equal number of spectra were taken in this position and in a corresponding position in the northern hemisphere.

Spectra in the 1100-mm band of UKT14 revealed a repeatable absorption feature in the southern hemisphere of the order of 5% of the continuum background. This feature is centred on coincident lines of HCN and PH3, and at the time of writing we are not able to confirm which molecule is responsible. Measurements in the 850-mm filter may enable us to distinguish between them by revealing (or not) the 4-3 HCN absorption, however at the time of writing these spectra have not yet been analysed.

Spectra in the 750-mm band of UKT14 did not reveal any H2S absorption features. Several transitions occur in this filter. We infer that tropospheric H2S was not generated by the impacts.

What does it mean?

Although it is far too early to come to any definite conclusions, here are some preliminary thoughts.

1) HCN is not normally present at detectable levels in Jupiter's atmosphere (in fact, it has never been detected before). Given the small size of the impact regions, it is clear that it was produced in large quantities by many of the impacts.

2) The narrow line widths (generally less than 10 km/s) imply that the emission originates from the upper stratosphere rather than from deeper levels in the atmosphere.

3) The origin of the HCN is uncertain. It is thought to be unlikely that it is being dredged up from the deep atmosphere. It could be brought in by the comet itself, or created by chemical reactions caused by the impact. It will require careful analysis of these and other observations, and detailed chemical modelling, to answer this question.

4) Our observations show that the HCN persisted over timescales of days following the collisions. The two 3-2 spectra of the fragment R site show that the line width and shape remained unchanged over a 48-hr period, while the intensity decreased by a factor of more than two. This suggests changes in the stratospheric abundance of HCN rather than temperature or pressure of the emitting gas.

Conclusions:

Despite the bad weather, it was a successful campaign. Our JCMT observations of stratospheric HCN include the only submillimetre detections of the SL9-Jupiter collision. We were able to formulate a picture (albeit incomplete) of the decay of the HCN emission in the days following the impacts . It will take some thought and consideration of our results in the context of other observations to sort out the implications for Jovian and cometary chemistry. The detection of tropospheric HCN or PH3, whichever it turns out to be, is certainly unique and will also have significant implications for the chemical models. On the whole we were excited to be part of this event, despite the weather; but having spent the last two weeks at HP, we be feel happy to let somebody else do it next time.

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Millimetre Continuum Observations of IRAS 22343+7501

The IRAS point source 22343+7501 is embedded in the L1251 molecular cloud. Initial observations of this object were made at near-infrared wavelengths, whereupon we discovered several discrete sources embedded in the cloud. This prompted us to obtain observations at several wavelengths, to try to understand as much about the nature of the source as possible.

We note present mm continuum service observations (CANSERV) of IRAS 22343+7501, obtained in August 1993 with the JCMT and UKT14 bolometer (more details may be found in Rosvick & Davidge 1994). The source was detected at 1.3, 1.1 and 0.85 mm only; shorter wavelengths were not possible at the time of the observations, due to poor sky conditions. Table 1 lists the results.

Wavelength (mm)	Flux (Jy)
1.3	0.232 (0.024)
1.1	0.383 (0.030)
0.8	0.710 (0.114)

Table 1: Millimetre continuum observations of IRAS 22343+7501. Quantities in brackets refer to 1 sigma errors.

Our near-infrared observations and the IRAS far-infrared observations indicated that the source is just past the protostellar phase of its evolution. The mm observations confirm this; Cabrit & Andre (1991) obtained 1.3 mm continuum observations of 25 embedded sources and found that their sources with molecular outflows have much higher 1.3 mm fluxes. The 1.3 mm flux for IRAS 22343+7501 falls within the outflow values of Cabrit & Andre, thus supporting the existence of an outflow as discovered by Sato & Fukui (1989) and the young age of this object.

Part of our analysis involved the construction of a spectral energy distribution from mm to near-infrared wavelengths. Figure 1 contains the mm portion of the spectral energy distribution, plus one IRAS observation at 100 microns, as well as a blackbody model distribution, shown as a dashed line. We calculated the model by estimating values for the dust temperature (37 K), source size (1.5 x 10-10 sr) and dust optical depth (which is given by the frequency of the observation divided by the frequency (3.0 x 1012 Hz) at which the dust becomes optically thin, raised to the power of 1.4). The match between the model and the observations is quite good, implying a single dust temperature in this wavelength region.

We estimated the mass of the circumstellar material using the 1.3 mm flux, the opacity per unit mass column density (0.02 cm2/g), the Planck function at 1.3 mm for a dust temperature of 37 K, and the distance to the source (200 pc). The above assumes the dust emission is optically thin and isothermal at 1.3 mm, which results in an approximate value of 0.04 solar mass.

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Evolution of Circum-Protostellar Environments

We are engaged in a program to survey the circumprotostellar environments of a complete sample of low-mass protostars in Taurus, whose infrared (Tamura et al 1991) and mm/sub-mm properties (Moriarty-Schieven et al. 1992, 1994) indicate them to be younger than T Tauri stars. We have recently completed a sub-mm photometric survey of our sources at the JCMT, ranging in wavelength from 450 mm to 2mm. Beckwith & Sargent (1991) have observed the mm/sub-mm emission from a selection of T Tauri stars in Taurus, which have similar luminosities to our younger sources. The range of flux densities seen for the two types of object were similar, suggesting that the masses of the circumstellar envelopes/disks were also similar. Let a be the slope in the relation S(n) ~ l-a. Then, when we compare the slopes of the spectral energy distributions (SED), we found that there was a significant difference between embedded sources and optically visible T Tauri stars. The older, more evolved T Tauri stars had a significantly shallower SED at mm/sub-mm wavelengths than the younger, embedded sources. This is clearly shown in Figure 1.

This dichotomy is clearly a sign of the evolution of the circumstellar envelope/disk. As the protostar evolves, one expects changes in the properties of the disk/envelope. The envelope presumably shrinks as it accretes onto the circumstellar disk, while the disk should become more optically thick as it builds up mass. One might also expect that the dust properties themselves will change, since the standard model for planet formation starts with the growth of dust particles. Both effects can be expected to affect the SED of the disk/envelope at long wavelengths. For example, the more optically thick disk in the evolved object may tend to dominate the SED at longer wavelengths, making the spectral index shallower (Butner, Natta, & Evans 1994). Also, in a denser disk environment, dust particles should be growing "fluffier", changing the dust emissivity law (index b). Spherical dielectric grains have b = 2 (Draine & Lee 1984), while "fluffy" fractal particles may have b <=1 (Wright 1987). Miyake & Nakagawa (1993) have indeed shown that as spherical dust grains grow to sizes comparable to sub-millimeter and millimeter wavelengths, their emissivity laws become much smaller. The much shallower SED for the more evolved objects is thus probably due either to the growth of the circumstellar disk at the expense of the envelope, or to the growth of the dust particles themselves, or perhaps is due to both effects.

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The Shortest Wavelength Detections of SgrA

Introduction

Sgr A* is a compact synchrotron radio source located at or very close to the dynamical center of the Galaxy. It is believed to be a starved black hole of roughly 2 x 106 M¤ (e.g. Falcke et al. 1993). Its radio spectrum below 100GHz is flat or slightly inverted and varies on time scales of a few months. In the short mm and submm range the spectrum rises more steeply (e.g. Zylka et al. 1992 - ZML92). No positive detections of Sgr A* at FIR and MIR wavelengths have been reported, but upper limits in the 8-18 micron range (Gezari et al. 1994) indicate that the spectrum must drop by more than an order of magnitude between the submm and the MIR regime.

The exact point of this turnover has been a matter of some debate in recent years. ZML92 claimed a 350 micron detection of SgrA* (with a large beam) of 18 ±9Jy, while Dent et al. (1993) clearly showed with the higher resolution of JCMT that this flux must be arising from the circum-nuclear disk (CND) surrounding SgrA*, and they placed an upper limit to its 450-micron flux of 1.5Jy. Both ZML92 and Dent et al. (1993) detected SgrA* at 800 microns, but with fluxes indicating that the source is varying on timescales less than a year.

Results

We obtained long-term status on JCMT (M/94A/U19) to answer the two questions: At what point in the submm regime does the spectrum turn over? What is the nature of the variability of the submm spectrum? To answer the first question we attempted to map SgrA* at 600 microns, in addition to 800 and 450 microns. To answer the second question we will be returning to JCMT in each of the next two semesters to repeat the observations. The results from the first run, outlined here, will be reported in Zylka et al. (1994, A&A in prep).

During the excellent weather conditions of Feb 27 to March 1 1994, with 230-GHz opacity below 0.03 throughout, we made raster on-the-fly maps, using the single channel bolometer UKT14, of the Sgr A region. Figure 1 shows our results in the form of isophotal contour maps of the region at 800, 600 and 450 microns. The axes are marked in arcsec offset from the position of SgrA*. The maps shown represent a combination of 5 maps at 800 microns, each with 1 second per point integration, and 7 and 9 maps respectively at 600 and 450 microns, each with 2 seconds per point integration.

The bright source seen at the centre of the 800-micron map is SgrA*, and the source can also be seen in each of the other 2 maps. These maps represent the first detections of SgrA* at 600 and 450 microns. However, the maps all show the structure of the surrounding region consistent with that seen in previous 800 & 1100 micron maps (eg: Dent et al. 1993). The CND extends over the central 12pc of the Galaxy. At a galactocentric radius of roughly 1pc the dust and hydrogen column densities drop to low values and form the Central Cavity. Our submm images show that the bottom of this cavity is rather flat, in agreement with Dent et al. (1993), and that Sgr A* sits in the centre. By fitting gaussians to SgrA* at each wavelength, we obtain fluxes of 3.5 ±0.5 Jy, 4.0±1.2 Jy and 3.0 ±1.0 Jy at 800, 600 and 450 microns respectively. Hence we observe a flat spectrum throughout the submm regime.

Our 800-micron detection of SgrA* is just consistent to within the combined errors with the values of Dent et al. (1993) and ZML92. However the full range of observed 800-micron flux densities for SgrA* is 3.1 - 5.6 Jy. These measurements have been made with different telescopes, and varying calibration problems. Therefore we intend to repeat the 800-micron measurements on a six-monthly timescale, using the same telescope, with the same calibration, to check whether this variation is real, or simply an artefact of different calibrations. Our detection at 450 microns is higher than the upper limit of 1.5Jy found for SgrA* by Dent et al. (1993). This appears to indicate that the source is variable at 450 microns on timescales of order 2 years, which we will also attempt to verify.

Conclusions

Our new data have resolved some of the existing paradoxes associated with the spectrum of SgrA*, by ruling out any dust model for the emission mechanism. In addition, our new detections at 450 and 600 microns will enable us to model the synchrotron emission mechanism which our data appear to support. Due to the variable nature of this mechanism we plan to continue to monitor this source at JCMT over the next 2 semesters to more tightly constrain the model.

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First Results from FANATIC: A New 690 GHz SIS Receiver

A sensitive new radiomenter, excellent weather, and a newly adjusted dish combined to make the first FANATIC observing run on the JCMT a smashing scientific success. FANATIC replaces the Schottky RxG, which had been in operation at the JCMT for the past several years. This new system saw its first light on the JCMT during semester 94A in March 1994. FANATIC's mixer is an SIS tunnel junction which was fabricated at the Institut de Radio Astronomie Millimemetrique (IRAM) in Grenoble, France (Schuster etal 1993). The local oscillator is a solid state Gunn oscillator followed by a doubler and a tripler. The LO is tunable with sufficient power to drive the mixer over a range from 660-695 GHz. The DSB receiver temperature is about 800 K over most of the band, factors of 3-5 improvement over the Schottky system(Figure 1). The backend for the system is the RxG 1.1 GHz acousto-optical spectrometer, with 1.2 MHz channel spacing. A complete description of the system is given in Harris etal (1994).

To determine the beam distribution of the system on the sky we made a series of five-point maps at a range of spacings from the center of Jupiter. Assuming that, as in the past, the distribution was best fit by a composition of 2 Gaussians, we fit convolutions of Gaussians with a disk to the five-point data. The result of these fits shows that 40% of the power that couples to Jupiter is in a 7 arcsec beam and the remaining 60% is in a 20 arcsec error beam component (Harris etal 1994). The absolute coupling to Jupiter is 0.20.

We observed several sources which were previously observed with the Schottky system to cross-check the intensity scales and found agreement to within 10%. This agreement in relative calibration indicates that the system is well behaved and that we have correctly determined the coupling efficiency.

Here we present a short summary of two new results from this run. Other results from FANATIC are also presented in this Newsletter in articles by Matthews and Thum, and Macleod etal.

Mapping and a Spectral Line Survey of the Orion Core

Wideband spectral line observations are complementary to spatial mapping. While spatial mapping yields information on the extent and excitation centers of sources, line observations yield information on the dynamics, energetics and chemistry within a beam. For example, Blake etal (1987) used information from over 800 lines in the 1.3 mm spectral region to identify distinct sources with izes smaller than the beam and to calculate the physical conditions in these sources. In order to get both spectral and spatial information about the excited gas in the Orion hot core and plateau areas, Harris etal have spatially mapped the region in the H13CN J=8-7 line and have measured the spectrum from 685-692 GHz with FANATIC.

Figure 1. DSB receiver noise temperature vs. tuning frequency, averaged over a 500 Mhz IF bandwidth.

For the mapping part of the program, we chose the J=8-7 of H13CN to point out the regions with dense, highly excited gas. The map was made on a 4 arcsec grid. Figure 2 shows the spectra from the map. The emission in this line is very compact, suggestive of acentrally condensed density distribution in this core region. The size of the H13CN core emitting region is 4-6 arcsec, similar to that of the NH3 and millimeter continuum regions (e.g. Genzel etal 1982; Wright and Vogel, 1985; Schilke etal 1992).

The position of the H13CN peak was chosen to be targeted in the spectral survey. The frequency range from 685.3 to 692.1 GHz was chosen for the scan because of the plethora of strong lines present in this band. The observations were made in steps of 300 MHz, such that each line was observed twice in the 700 MHz bandwidth of FANATIC. This procedure has allowed us to separate unambiguously lines from each sideband.

Based on their linewidths two types of lines are seen in the scan: broad lines coming from the plateau region, and strong, narrow lines presumably arising from the compact ridge. Interestingly, lines with widths characteristic of the hot core region itself are not seen.

Lines of SO are especially prominent and broad, exhibiting widths which indicate that they arise from the plateau. Also seen are narrow lines of CH3OH which are attributable to the compact ridge. The sensitivity limit of the survey is a few degrees, and it is somewhat surprising that the forest of lines which appear in Orion surveys at lower frequencies is not evident in our survey. In particular, no lines from heavy species such as ethyl cyanide, methyl formate, or dimethyl ether are detected, nor are any species with line temperatures of 5-10 K. This may be in part due to the fact that at these high frequencies we are beyond the peaks of the excitation curves for the heavy molecules, which contribute so many lines in lower frequency surveys.

A full description of this work will be found in Harris etal (1994).

Extended Warm Dense Gas in M82:

The mid-J lines of CO can be used as a very sensitive diagnostic of the temperature and excitation properties of the molecular gas present in the nuclei of starburst galaxies. In nearly all nuclei where multiple lines of 12CO have been observed the emission is found to be optically thick. The distribution of CO intensity with J is rather flat, and then there is a decrease in intensity as the CO becomes subthermally excited. The transition at which this `rollover" occurs is very sensitive to the pressure of the molecular gas. For those galaxies with large UV radiation fields and warm molecular gas, as is the case for starburst and active galaxies, the rollover in intensity is likely to occur somewhere in the mid-J transition range.

Figure 2. Map of the H13CN J=8-7 line in the Orion core. The temperature scale is Tr*, with eta(fss)=0.2, appropriate for coupling to a Jupiter-sized source. The map centre is Irc2: RA(1950) = 5h 32m 47s, Dec (1950) = -5d 24' 23".

With the increased sensitivity of FANATIC over the RxG Schottky system, it has become possible to more easily map out the distribution of the warm, dense gas as traced by the CO 6-5 line in a number of nearby bright galaxies. Previously, emission from the 6-5 line had been detected in the nuclei of 3 nearby starburst galaxies: M82, NGC 253 and IC 342 (Harris etal 1991). The intensities of the 6-5 emission in these galaxies indicate a large amount of warm gas in their nuclei. We have now studied the nucleus of M82 in more detail by mapping the distribution of the 6-5 line over the central 25(??) arcsec in its nuclear region.

We were able to map around both the NE and SW low-J CO lobes, in the nucleus itself, and along the major axis. Through line pointing on M82 itself with RxB3i in the 3-2 line, we were able to establish the relative pointing from night to night. The extent of the 6-5 emission is large. We detect lines throughout the central 20" of this galaxy, in the nucleus as well as in the CO lobes (Figure 3).

Figure 3. Sample spectra from our 12CO J=6-5 map in M82: (a) the peak of the NE CO lobe; (b) the nucleus; and (c) the peak of the SW CO lobe. The temperature scale is Tr*, with eta(fss)=0.2, appropriate for coupling to a Jupiter-sized source.

The 6-5 lines are peaked at the positions of the NE and SW lobes, similar to the distribution of low-J 12CO (e.g. Lo etal 1987; Tilanus etal 1991; Wild etal 1992). The emission is distributed throughout the nucleus, not conentrated in a nuclear core, or associated with the clusters of supernova remnants, as traced out by the 6-cm radio continuum emission (Kronberg, Biermann and Schwab 1985).

Such a distribution and the large extent of the 6-5 emission indicates that the gas is primarily being heated by large scale processes, and not by the input of energetic photons into the ISM by supernovae. The fact that the emission is so widespread means that clouds with bulk temperatures of about 50 K are prevalent in the central regions of M82. M82 may not be unique among starburst galaxies. Previous 6-5 observiations of NGC 253 with the Schottky RxG show that the 6-5 emission is also extended in that galaxy. Indeed, the gas which gives rise to the mid-J CO emission may well comprise a significant percentage of the molecular gas from galaxy nuclei.

Special thanks go to Lorne Avery for his help at the telescope, and to K.-H. Gundlach and B. Plathner for assistance with the junction fabrication at IRAM. As always the mechanical and software support during setup at the JCMT was outstanding. We also thank Per Friberg for his extensive help as the

FANATIC JCMT support scientist.

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H2 and CO images of the jet from VLA1623

The two images on the covers of this Newsletter show the jet from the class 0 young stellar object VLA1623 observed with JCMT and UKIRT. The back cover is the blue-shifted emission from J=3-2 12CO. This highly collimated flow has an opening angle of less than 10 degrees, and total length in CO of approximately 9 arcmin (0.4 pc). There is evidence of wiggles in the line of strongest emission, superimposed on an underlying cylindrical morphology, which suggests either a precessing or locally unstable high-velocity jet is accelerating the molecular gas. The front cover shows the region in shocked H2, taken with IRCAM3 on UKIRT. The three brightest objects are scattered continuum nebulae; however, several regions of the CO jet (eg at coordinates 100,-45" and -110,+85") are associated with H2 clumps and "streamers". This would indicate the presence of recently shocked hot gas.

The CO map was made by a prototype "on-the-fly" raster mapping technique using the DAS and RxB3i under rather poor weather conditions (Tsys~1500 K at 345 GHz). The map contains approximately 1700 spectra, each of 5 seconds integration. Total map size is 4 Mbytes. Continuous sampling is carried out while rastering the telescope across the object. At the end of each row, a single reference position is observed, with a calibration every few rows. Axes in both maps are given in arcseconds offset from the central embedded object VLA1623.

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Detection of Extended CO J = 6-5 Emission from a Nearby Outflow Source

MacLeod and Avery (1995, in preparation) have previously observed an unusual outflow source, located at 140 pc distance in Taurus, which appears to be partially hidden behind a strong absorbing screen of very cold, dense gas. The outflow is centred on IRAS 04368+2557, and most of the JCMT CO J=3-2 spectra which define it show very strong self-absorption, even well away from the centre of the source. In order to try to see through this screen and study the emission centred on the IRAS source, we observed this young stellar object in March 1994 at the JCMT with the Max Planck Institut fur Extraterrestrische Physik's new SIS version of Receiver G, known as "FANATIC".

The weather was excellent at the beginning of our JCMT run in March 1994. We started by observing a grid of ten points around IRAS 04368. From the first observation, it was clear that strong J = 6-5 lines of order Tr* = 10K were associated with the IRAS source. The grid map taken with the 7" half-power beamwidth showed that the central source was extended over a region at least 16" x 16". Furthermore, we have detected strong emission at several positions well out in the blue and red lobes of the outflow, notably at hot spots on the CO J = 3-2 map, shown in Figure 1. The blue- shifted emission is in the upper half, while the red-shifted emission is in the lower half of the figure.

Four CO J = 6-5 spectra are shown in Figure 2, superimposed on the CO J = 3-2 JCMT spectra from the same positions. The (Da = 0, Dd = 0) J = 6-5 spectrum at the position of the IRAS source (Fig. 2d) shows a central peak rather than a central dip, indicating that the dip in the J = 3-2 spectrum is due to self-absorption and is not two separate velocity components. This conclusion is supported by 13CO and C18O, in which the central absorption is much less prominent. This is also the case at (-10,10) (Fig. 2b), but the situation is not so clear at (100,30) (Fig 2a), where some hint of a dip in the J = 6-5 spectrum also exists. Fig 2c illustrates that no J = 6-5 emission is detected at the southern tip of the blue- shifted CO J=3-2 hot spot.

In all, some 20 positions were observed in CO J = 6-5 before the weather deteriorated. Of these, 16 were detections and 4 had no line. Each J = 6-5 spectrum shown in Figure 2 has an integration time of only 4 minutes, illustrating the excellent sensitivity of the new SIS receiver.

These observations represent the first time, to our knowledge, that a highly excited CO transition has been detected in the outer regions of a low-luminosity bipolar outflow. The upper energy level of the 6-5 transition of CO is 116K above the ground state, so there is a relatively high excitation temperature in the core and at the hot spots. In particular, the J = 6-5 emission at the CO J = 3-2 hot spots may be arising from shocks occuring at the point where a stellar wind or neutral jet is colliding with dense clumps in the ambient medium.

Figure 1. JCMT map (both greyscale and contours) of the CO J=3-2 bipolar outflow surrounding IRAS 04368+2557 in Taurus. The map center is at RA(1950) = 04h 36m 49.30s, Dec(1950) = +25d 57' 16". The upper half of the figure shows the blue lobe, with emisison integrated over 2 km/s < v(lsr) < 5 km/s. The lower half of the figure shows the red lobe, with emission integrated over 7 km/s < v(lsr) < 10 km/s. The beamwidth was 14".

MacLeod and Avery (1995, in preparation) have also mapped HCO+ J = 4-3 over a 50" x 50" region centred on the IRAS source. Strong HCO+ emission is found in this region, and there is a tendency for this emission to outline the walls of the outflow bubble close to the source. An integration at the peak of the blue hot spot at (100,30), however, detected no HCO+. This could be because the density at this position is too low to excite the HCO+ J = 4-3 line, or perhaps HCO+ may be destroyed in the shock. However, both of these explanations are problematical, in that the presence of strong CO J = 6-5 emission suggests a relatively high density, and the theoretical calculations of Pineau des Forêts et al (1988) indicate that the abundance of HCO+ across a shock should show very little variation. The lack of HCO+ emission at this hot spot is therefore puzzling. We intend to investigate other indicators of the presence of shocked gas, including CH3OH and SiO, in the hot spots of the IRAS 04368 outflow.

What do we know about IRAS 04368+2557 from other observations? It is a relatively cool young stellar object located in the molecular cloud Lynds 1527. Its continuum flux density rises steeply throughout the infrared to a flux density of 71 Jy at 100 microns, and it has a far infrared luminosity of 2.9 L¤. Benson and Myers (1989) have found an ammonia core associated with this object. They calculate the radius of the core to be 0.08 pc, and find that it has a mass of 2.4 M¤ from their NH3 observations. The core has a high visual extinction of ~ 1000 magnitudes. Ladd et al (1991) have used the JCMT to detect 04368 at submillimeter wavelengths, and they mapped it at 450 microns and 800 microns. They found a source size of about 30" diameter. The continuum spectrum suggests that 04368 is a low-mass star at a very early stage of formation.

Figure 2. JCMT spectra at selected points within the outflow. The upper spectrum in each box is CO J=3-2, while the lower spectrum is CO J=6-5. The ordinate Tr* (Jup) is Tr* calculated from the main beam efficiency measured on Jupiter.

We believe that nearby outflow sources in Taurus such as IRAS 04368+2557 provide us with an excellent opportunity to study with high spatial resolution the complex interaction which takes place between outflowing gas and the surrounding interstellar medium during the formation of low mass stars.

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The Hydrogen Recombination Masers

Background

Maser activity in radio recombination line (RRL) emission was first recognized in 1988 in data obtained with the IRAM 30 m telescope [4]. One of the latest additions to the family of astrophysical masers, this new phenomenon has been detected so far only in the circumstellar shell of the optically inconspicuous Be star MWC349. Investigations over a wavelength range of 1 to 3 mm, showed that the maser activity begins near 100 GHz. The maser line flux *FL* grows rapidly with increasing frequency, reaching an easily detectable antenna temperature of ~2 K at H30a (transition between principal quantum numbers *n* = 31 ® 30) near 232 GHz.

The RRL maser profile includes two ~14 kms-1 wide spikes superposed on a weak and broad pedestal feature (Fig.1). Interferometry with OVRO at 1 mm [6] has shown that the two spikes, dubbed `blue' and `red', are separated by 80 a.u. in a direction coincident with the orientation of the neutral circumstellar disk inferred previously [1, 3, 13]. It is therefore thought that the maser is located along symmetrical *tangential* lines of sight where, on a rotating disk, the velocity shear is a minimum [2, 10]. If the velocity separation of the blue and red spikes, ~50 kms-1, truly reflects the rotation velocity of a Keplerian disk, a central (stellar) mass of 30 M¤ is implied.

An important property of a maser is whether it is saturated or not. For the RRL maser, evidence from small but systematic variations of the width of the spikes and from the variabilty of their flux suggests that the degree of saturation increases systematically with frequency, showing signs of saturated behavior beginning near 1 mm.

Why ever higher frequencies?

The systematic increase of maser line flux from 100 to 250 GHz suggested that the maser might be even stronger at submillimeter wavelengths and thus be easily detectable in the 0.85 mm atmospheric window. Theoretical considerations also suggested that the principal requirements of a maser, inversion of the level populations and sufficiently long coherent gain paths, are satisfied even at much higher frequencies. Walmsley's calculation [12] of the NLTE departure coefficients showed that the line absorption coefficient, *kL*, stays negative at submm wavelengths for a large range of electron densities *ne*. His work indicates that with decreasing quantum numbers *n* the (negative) *kL* peaks at ever higher *ne*. At H30a, for example, regions of *ne* = 107 cm-3 would be seen masing, whereas at H21a regions of ~108 cm-3 would contribute most. With increasing frequency, the RRL maser therefore probes denser regions of the sources, presumably located progressively closer to the center. We know that a range of densities up to values of at least 1010 cm-3 exists in the circumstellar disk [3].

Figure 1. Spectra of the H21a transition at 662.4 Ghz (top) and of the H26a transition (bottom), both obtained with the JCMT on March 9th, 1994 within the space of 4 hours. For the H21a line, a new SIS receiver built by the MPE Group [8] was used. The sky opacity at zenith was ~0.75, integration time was 1.1 hours.

Another even more intriguing aspect of Walmsley's calculations is that the (negative) *kL* maxima increase with frequency. An ever shorter path *s* is needed for the higher frequency transitions to achieve unit gain. While for H41a (near the onset of the maser activity) *s* is of the order of 200 a.u., which is conspicuously close to the inferred outer disk diameter [13], *s* is only ~30 a.u. at H30a. This suggests that the maser gain is increasing with frequency, and the question arises where does all this stop?

Apparently not with the H26a transition. We have observed the 353.6 GHz transition several times with both the JCMT and the 30 m telescope [9] and it follows the predicted pattern of increasing line flux and saturation very nicely. We were therefore compelled to try an even higher frequency transition, and we chose H21a at 662.4 GHz, which is located in a frequency range where the atmospheric opacity is still not prohibitively large. The JCMT is the telescope best suited for such a study and a good receiver is available thanks to the long-standing cooperation between the Max-Planck-Institut für Extraterrestrische Physik and the Joint Astronomy Centre.

Getting data at the edge of feasibility requires, among other things, patience. In our case, more than 4 years have passed from the first proposal until successful observation (and publication [11]). We were rewarded with a high--quality detection of H21a (Fig. 1), constituting the highest frequency recombination line observed with radio techniques, and at the same time the highest frequency astrophysical maser of any kind.

Why did it take us so long? Poor high frequency weather accounts for most of the delay, and we think that success was possible at the end due to a combination of several factors: decent weather, an excellent receiver, an efficient telescope at 662 GHz, the presence of the receiver builders on the mountain, and flexible scheduling of the telescope. A general summary of this winter's high frequency observations on the JCMT is given elsewhere in this issue by Andy Harris and Linda Tacconi.

New results

The most striking finding from the H21a spectrum is that the maser flux is still increasing. Fig. 2 shows that the increase is well described above 250 GHz by a power law spectral index a = 3.4. Some of this growth is simply due to the line width. Since it is nearly constant in *velocity*, its frequency width grows linearly with n, and the line flux density grows then as a ~2.4. This value is very similar to the spectral index of the line absorption coefficient, as would be expected for saturated growth.

The velocity separation of the blue and red spikes of the H21a transition is found to be 50.6 ±0.2 kms-1, indistinguishable from the H26a value. This result came as a big surprise, since we expected the H21a maser to originate much closer to the center than the lower-frequency transition, where a Keplerian disk would rotate much faster. This dramatic velocity increase is not seen. The explanation of this confusing finding could be that the disk is braked inside the H30a emission radius, or even stranger that the density structure in the inner disk is rather peculiar. An interferometric measurement of the angular separation of the H26a spikes would help to find the answer.

Measuring wind speeds

Despite the overall similarity of the H21a and H26a spectra there are some interesting differences which are evident in the H26a/H21a ratio spectrum in Fig. 3. The relative increase in line strength is least at the radial velocities of the maser spikes, while the ratio is much higher between the spikes. This testifies again in favour of saturated growth of the spikes, but it also means that the low velocity gas, likely originating mostly on the disk near the central line of sight, is also subject to maser amplification.

Figure 2. Line fluxes (time averages when several observations are available) of maser spikes. Transitions n+1 -> n in the range n = 41 ... 21 are shown.

The two most prominent peaks in Fig. 3 are at extreme velocities, much beyond those thought to occur within the disk. We attribute these peaks to stimulated (weak maser) emission of gas in the strong ionized wind. Conditions for amplification in the nearly spherically expanding wind are optimal along the central line of sight in front and to the rear of the star. Their mean velocity, *vc* = 8.5 kms-1, is in good agreement with the velocity centroid of the maser spikes, and lends support to the interpretation of *vc* as the stellar velocity.

Furthermore, in this interpretation the velocity separation of the peaks would then measure twice the expansion velocity (i.e. wind speed) of the gas emitting at submm wavelengths. The wind speed inferred from this novel method is somewhat smaller than the conical value of 50 kms-1, but not greatly so. Whether this means that at submm wavelengths we start to see into the acceleration region of the wind, awaits further analysis.

Is MWC349 unique?

Given the highly controversial physical nature of MWC349, the only known source of a RRL maser, we (and others) have spent considerable effort in searching for a second maser in a large variety of astronomical objects, so far in vain. Probably the most telling result is the absence of masers in Wolf-Rayet stellar winds [5]. Given their strong ionized winds, optical depths should be high enough (and inversion is ubiquitous) for masers to occur. We interpret our failure to mean that Wolf-Rayet stars do not have the disk structure, or velocity coherence, required for RRL maser emission.

We have monitored the maser in MWC349 at many transitions over the previous 5 years. We find that the basic double-peaked pattern is remarkably stable. In particular we find only minute variations of the spike velocity separation, in contrast with the considerable independent intensity changes of the spikes. This is not the behavior expected from a disk created by violent mass loss, typical of the final stages of a star's life. The pattern relates more naturally to a steady and massive disk, such as those built up by accretion. The high central mass derived from the disk rotation and the high ionizing luminosity required by the presence of an ionized wind and the RRL maser then suggest a scenario in which a massive ZAMS star is observed during the fleeting period in its evolution when it is no longer obscured by its nascent cloud, yet its high luminosity and powerful wind have not yet succeeded to fully destroy its accretion disk.

Figure 3. Ratio of H21a and H26a spectra smoothed to a resolution of 2.1 km/s and plotted on a logarithmic scale. The velocities labelled B and R correspond to the blue and red maser spikes. The average velocity of the ratio maxima labelled front and rear is indicated by the vc arrow.

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Probing Magnetic Fields in Star-Forming Regions

Introduction

In the August 1992 JCMT Newsletter, we reported on our 800 micron polarimetric observations of Rho Oph A. These observations demonstrated the feasibility of mapping submillimetre polarisation across regions containing young stellar objects (YSOs), and showed that the magnetic field in the direction of the brightest peak of the Rho Oph A core, known as SM1 (Ward-Thompson et al. 1989), is aligned roughly constantly in the NE-SW direction. Also reported were our observations of W3-IRS5, a high-mass YSO, where we found evidence for a 'pinched-in' magnetic field. These combined results support models of bimodal star formation, as discussed by Greaves, Murray and Holland (1994).

We returned to JCMT in June 1994 to make further polarimetric observations of star formation regions. Observations were carried out of VLA1623, a very young protostellar candidate in Rho Oph A, to test whether the magnetic field direction alters in the vicinity of this object, compared to that in the rest of the cloud core. We also observed a double core system in S106, comprising a massive YSO (S106 IR) and a submillimetre source which may be another protostar candidate (S106 FIR), to investigate if their magnetic fields were related.

Observations

The observations were made in June 1994, using the Aberdeen/QMW polarimeter, in conjunction with the common-user photometer UKT14. We observed at 800 microns, where the instrumental polarisation is minimum (0.5%) and the spatial resolution is high (14" beam). A 16-position waveplate cycle was used, to give 4 independent estimates of percentage polarisation and position angle in a 10 minute integration, and the data were analysed using Ramon Nartallo's SIT software.

The inferred magnetic field directions are perpendicular to the polarisation vectors. This is because the submillimetre polarisation, which arises from thermal emission by aligned non-spherical dust grains, is predominantly along the long axes of the grains. The exact mechanism of alignment is still a matter of some debate, but for all mechanisms the long axes, and hence the polarisation, are perpendicular to the direction of the magnetic field.

Figure 1. Polarisation map of SM1/VLA1623 at 800 microns. The direction of polarisation appears to be roughly constant across the whole region, inferring a magnetic field direction running roughly NE-SW through the cloud, even at the position of VLA1623, the southernmost polarisation vector.

Low-mass star formation: the case of VLA1623

The Rho Oph A core is a region of low-mass star formation, which has recently been shown to contain one of the youngest protostar candidates yet discovered, the prototype Class 0 source VLA1623 (Andre, Ward-Thompson and Barsony, 1993 - hereafter AWB). This source has an extended and extremely highly-collimated bipolar outflow aligned roughly NW-SE (Andre et al. 1990). Recent OVRO interferometer measurements, however, show no evidence for a circumstellar disk around VLA1623 (Andre, priv. comm.), such as was found around HL Tau (Keene & Masson 1990). The question therefore arises as to what is collimating the bipolar outflow. One possible answer to this question is that the large-scale magnetic field of the cloud is responsible for the outflow collimation. In this scenario the large-scale magnetic field in the molecular cloud should lie parallel to the direction of the bipolar outflow.

The results for Rho Oph A are shown in Figure 1. The three most southerly points are those obtained in the recent run. As the figure shows, the magnetic field deduced from the polarisation vectors is roughly parallel throughout the cloud core, lying roughly NE-SW - ie: perpendicular to the direction of the bipolar outflow. There is no evidence for any change in direction of the magnetic field from SM1 to VLA1623, where the field is aligned with the previous points, and also lies perpendicular to the outflow.

The case of VLA1623 therefore remains an enigma. Our results have shown that the large-scale field cannot be collimating the outflow. There is no apparent disk, and AWB have suggested a 'cored-apple' structure through which the outflow emerges. Further modelling is required to see if this structure, threaded by a toroidal or planar magnetic field, can collimate the outflowing gas.

High-mass star formation: the case of S106

The S106 HII region has a bipolar morphology, aligned roughly N-S, bisected by a lane of obscuration running approximately E-W. At the centre of the system lies the near-infrared source S106-IR . The dark lane was originally hypothesised to be a circumstellar disk. However, recent results (Richer et al. 1993) showed that, when observed with the high resolution of the JCMT at 450 microns, the supposed disk breaks up into a number of fragments, the brightest of which, S106-FIR, is a candidate protostar. We therefore obtained submillimetre polarimetry of S106-IR and S106-FIR to ascertain the magnetic field direction in these two sources, and to look for any correlation between the two.

Figure 2. Polarisation map of S106IR/S106FIR at 800 microns. The direction of polarisation of the two sources infers a magnetic field direction parallel to the broad lane of 800-micron emission.

Figure 2 shows an 800-micron isophotal contour map of S106, with the two submillimetre polarisation measurements at the positions of S106-IR and S106-FIR superposed. The dark lane of optical obscuration appears as an approximately E-W band of emission at 800 microns. It can be seen that the two sources are both polarised in a similar direction, and that the inferred magnetic field (perpendicular to the polarisation vectors) lies roughly along the lane of 800-micron emission. The alignment of the field directions in the two young objects may have interesting implications for our understanding of the formation of binary star systems.

Recent Zeeman observations (Roberts et al. 1994) detected a strong magnetic field in the lobes of the S106 HII region, with a much reduced field in the vicinity of the dark lane. This was interpreted as a large-scale magnetic field, aligned N-S, parallel to the alignment of the bipolar HII region, which is pinched into an hour-glass shape in the vicinity of the central star. Our observations appear to contradict this scenario, by showing that the field is lying roughly E-W in the vicinity of the star.

We therefore suggest a hypothesis to explain both our data, and the Zeeman data as follows: The large-scale magnetic field lies N-S along the bipolar HII region, but close to the star the field may be twisted into a toroidal morphology around the central star. The resultant field lies parallel to the dust lane in the small JCMT beam, but diverges back to the large-scale N-S field on larger scales. At the centre, the two competing field directions are seen simultaneously in the larger beam Zeeman observations, causing an apparent reduction in the observed magnitude of the magnetic field.

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