PROTO STAR

NEWSLETTER
of the
James Clerk Maxwell
Telescope

Kulia I Ka Nu'u

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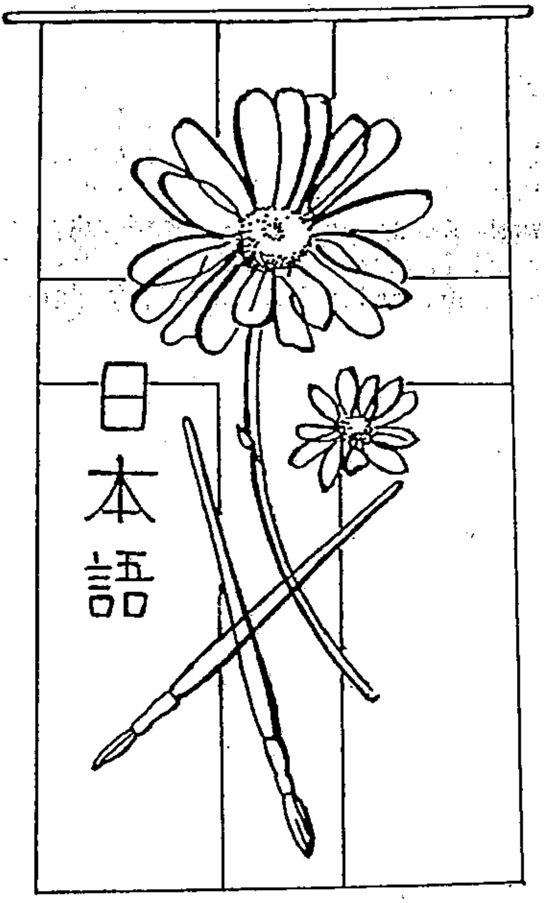
Margareta Sandell 1947-1990

It is with great sadness that we have to relate that on 7th June Margareta Sandell died in a tragic road accident in Finland. Many of the users of the JCMT will know her husband Göran who has been a support astronomer since 1986. The Sandells came to Hawaii from Helsinki, where Göran had held a post at the University. Margareta resigned a senior teaching post to accompany him to Hawaii, where she gained wide respect and admiration for her artistic talents and devotion to her family. Margareta will be very sadly missed by her many friends, both telescope people and others, in the Big Island and elsewhere.

We all extend our deepest sympathy to Göran, Joanna, Anders and Maria.



CONTENTS

RECENT RESULTS FROM THE JCMT

CO(J=3-2) MAPPING OF M82

The peculiar galaxy M82 is the most observationally accessible starburst galaxy, with a far-IR luminosity of 3 x $10^{10}L_{\odot}$. In the inner region of M82, CO and HI observations show a double-peaked structure, which has been interpreted as a rotating molecular ring with a radius of 250 pc. M82 is peculiar also in its high ^{12}CO(2→1)/^{12}CO(1→0) ratio (~2), which indicates that the molecular gas has low optical depths if the excitation temperature of the gas is close to the temperature of the dust (~50 K). A low optical depth is claimed to be supported by the findings of relatively large ^{12}CO/^{13}CO ratios for the 2→1 and 1→0 transitions. However, the ^{12}CO/^{13}CO ratio (≤ 20-30) implies an optical depth that is still too high to explain the 2→1/1→0 line ratio.

From observations at a few selected positions in the central region of M82, one finds the ^{12}CO (3→2) line strength to be lower than expected on basis of the 2→1 and 1→0 data. This discrepancy has been interpreted as evidence for a multi-component molecular medium i.e. the presence of a relatively low density and cold (interclump) gas which does not significantly contribute to the 3→2 emission. Owing to the unexpectedly low values of the 3→2 line in the central region of M82, this line can serve as a sensitive probe of the physical conditions of the molecular gas in this region. We have therefore made a full map of the ^{12}CO (3→2) line at 13.″7 (HPBW) resolution, closely matching the 1→0 data at 16″ (Nakai et al. 1987, P.A.S.J. 39, 685) and the 2→1 data at 13″ (Loiseau et al. 1990, Astr. Astrophys. 228, 331).

The ^{12}CO spectra were obtained, using the Berkeley 345 GHz SIS receiver system (Sutton et al. 1990, Int. J. Infrared Millimeter Waves 11, No. 2, 113), with the JCMT during a two week period in March 1990. We have also obtained spectra of the ^{13}CO(3→2) line at 330 GHz for three positions: on the nucleus and on either peak of the ring at a galactocentric distance of 12″ along the major axis. At 345 GHz the receiver had a typical double sideband (DSB) noise temperature of 400 K. The system temperature, including atmospheric losses, was typically 1200 K single sideband (SSB) on nights of good transparency. The system noise temperature was roughly 20% lower for observations of the ^{13}CO transition at 330 GHz. As a backend we used the AOSC. The effective resolution of the receiver/spectrometer combination was 0.45 MHz. We used the chopping secondary, which was still being commissioned at the time, to obtain better baselines.

The ^{12}CO(3→2) emission was mapped in a 1′ x 0.′5 region centered on the 2.2μm emission peak: RA(1950)=$9^h51^m43^s.9$ and Dec(1950)=69°55′01″. Spectra were obtained at 43 positions on a 6″grid (Figure 1a) aligned with the position angle of the major axis (taken to be 70°). The total integration times for the spectra were 4-10 minutes depending upon the atmospheric conditions, which were very good during half of the observation period ($\tau_{345} \approx 0.15$). Pointing was repeatedly checked by observing Jupiter and IRC+10216 and by using the distinct shape of the spectrum of the western ring-peak (grid position: -12″, 0″). No significant change of the profile was observed, indicating stable pointing throughout the observation run. The overall pointing during the observation run was good to ~ 3″r.m.s.

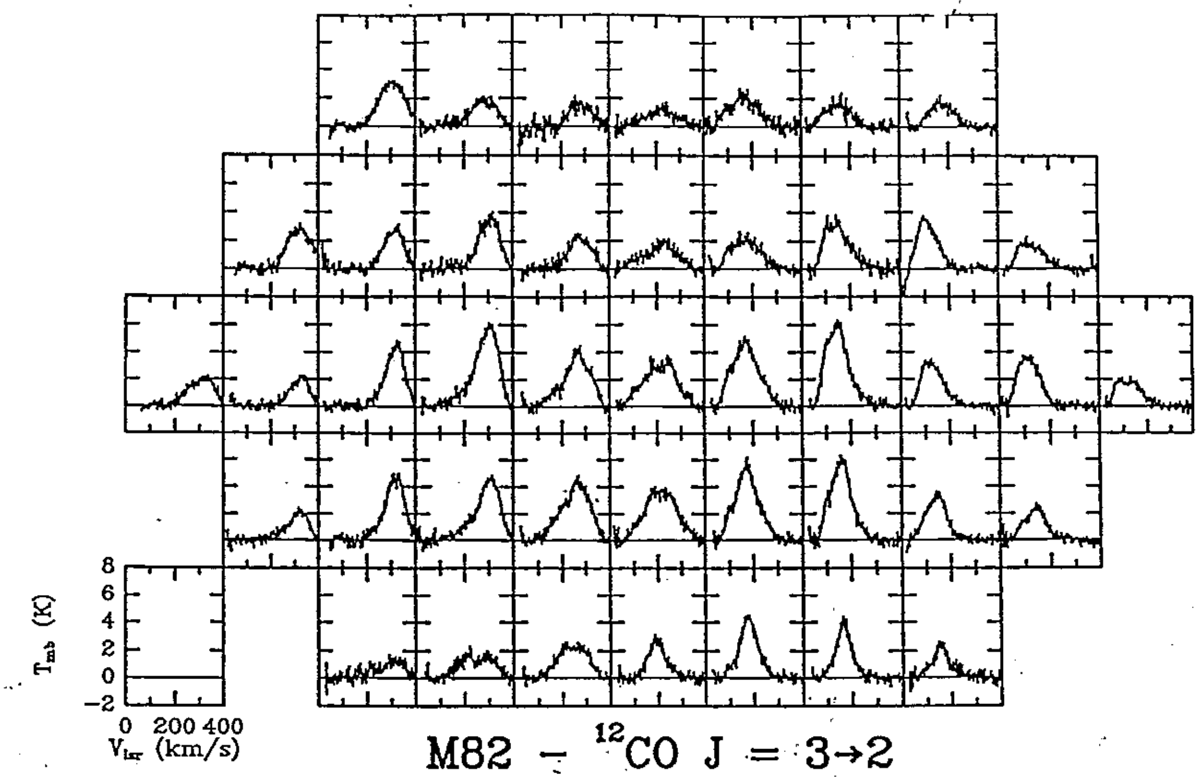


Fig. 1a: *The observed spectra of the ^{12}CO (3→2) line in M82, smoothed to a velocity resolution of ~ 2 kms^{-1}. The centre velocity of the profiles is 225 kms^{-1} (V_{LSR}). The temperature scale is T_{MB} (K).*

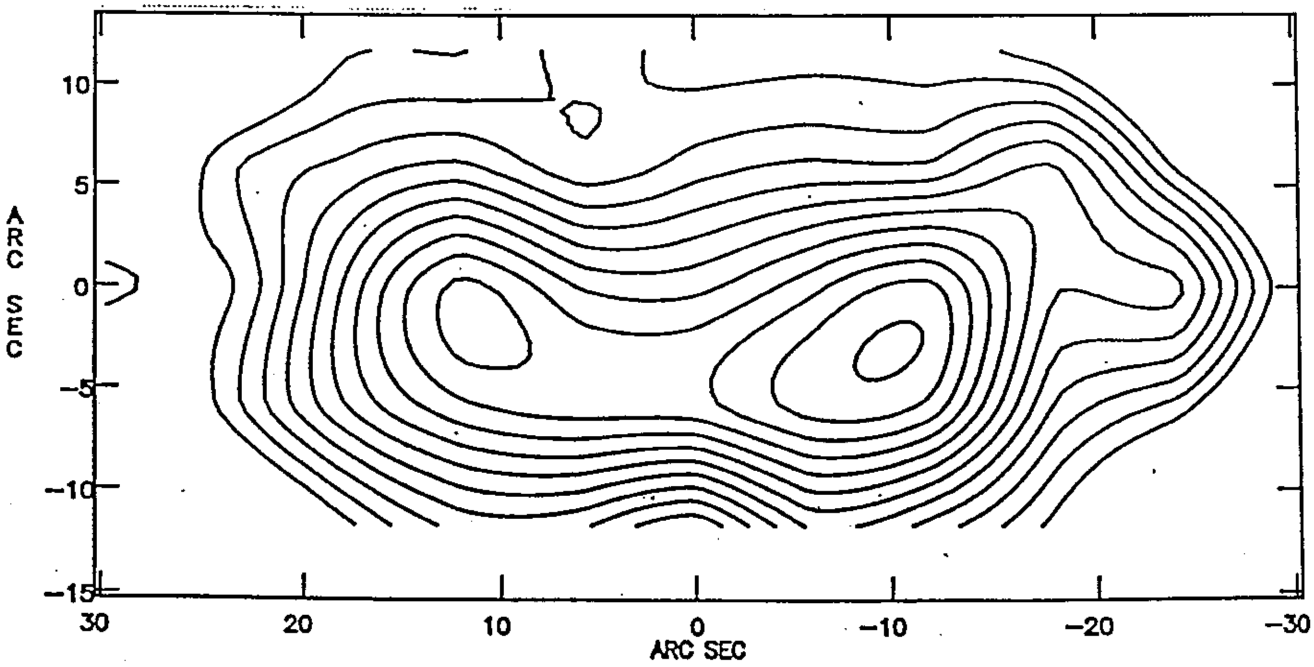


Fig. 1b: *The distribution of the integrated intensity of the ^{12}CO (3→2) line. The levels range from 100 to 375 kms^{-1}.*

The observed ^{12}CO spectra are shown in Figure 1a. The grid is in the coordinate system described above, with the X axis aligned with the major axis of M82. The intensity scale is in units of T_{MB} (T_A/η_{mb}). The spectra have been smoothed over 8 channels resulting in a velocity resolution of ~ 2kms^{-1}. We have not used the extreme edge of the band at the low-velocity side ($\leq$ 25kms^{-1}), because of baseline instabilities. For the whole field the general shapes of the profiles are in good agreement with the ^{12}CO(1→0) observations, and the ^{12}CO(2→1) observations. Our observations confirm the rather low 3→2 line strengths reported in earlier work.

Figure 1b shows the integrated intensity distribution of the ^{12}CO(3→2) ($I_{CO} = \int T_{MB}dv$) in the central region of M82. The map clearly shows the double-peaked structure seen at other wavelengths and associated with the molecular ring. The ^{12}CO and ^{13}CO (3→2) spectra and their ratio are shown in Figure 2 for the positions of the nucleus and the two ring-peaks. The average ^{12}CO/^{13}CO ratio we observe is about 10, except for the eastern-most ring-position where the ratio varies between roughly 10 and 40 across the profile. The zero-level of the ^{13}CO profile at this position, however, is rather uncertain due to the unstable end of the baseline, which, owing to the different sideband, is at the high-velocity side of the ^{13}CO profiles.

Our detections of the ^{12}CO and ^{13}CO (3→2) transitions have important implications for the general conditions of the interstellar medium in M82. First, the ^{12}CO to ^{13}CO (3→2) ratio of peak line temperature is about 10, implying an optical depth of ~ 7 for a ^{12}CO/^{13}CO abundance ratio of 70. For this optical depth, a ^{12}CO (3→2/2→1) line-temperature ratio of at least 1 is expected for LTE cases. Hence, the observed ratio of 0.6 (Table 1, see also the next paragraph) indicates that either the effective surface filling factor or the excitation temperature is less for the 3→2 than for the 2→1 emission. The former possibility can arise from density gradients within the clouds since the critical density for the 3→2 transition is about a factor of 4 higher than the 2→1 transition. We are mainly concerned with the 'average' conditions of the molecular clouds, and will explore the characteristic temperature and density of the gas that is producing the bulk of the emission, under non-LTE conditions.

In order to derive the temperature and density of the molecular clouds, we combined our data with observations of the lower J transitions of ^{12}CO and ^{13}CO at 1→0 and 2→1, and compared the line intensities at the positions of the nucleus and the ring-peaks. For the three positions we find the line ratios to be constant within the errors. The average of the peak line temperature at the three positions is shown in Table 1 for the various transitions. Admittedly, the CO line temperatures vary across the line profiles as well as with position in the galaxy. Hence, the results based on the values in Table 1 should be considered only in an average sense as being representative for the central region of M82. The errors quoted in Table 1 reflect the uncertainty of the overall calibration of the temperature scale at the various telescopes, which is much larger than the uncertainty due to noise and baseline subtraction. Shudong Zhou has used a Large Velocity Gradient model of radiative transfer and a χ^2 minimization routine to derive the physical parameters that fit the data best. Using the average values in Table 1 for the central region of M82, we find as best fit T_K = 50 K, $n(H_2) \approx 4 \times 10^3$ cm^{-3}, a column density $N(CO)/\Delta V$ of 1.7×10^{17} cm^{-2}/kms^{-1}, and a filling factor f_s equal to 0.15. This result indicates that the molecular gas in the central region M82 is both hotter and denser on average than the molecular gas in the Galaxy.

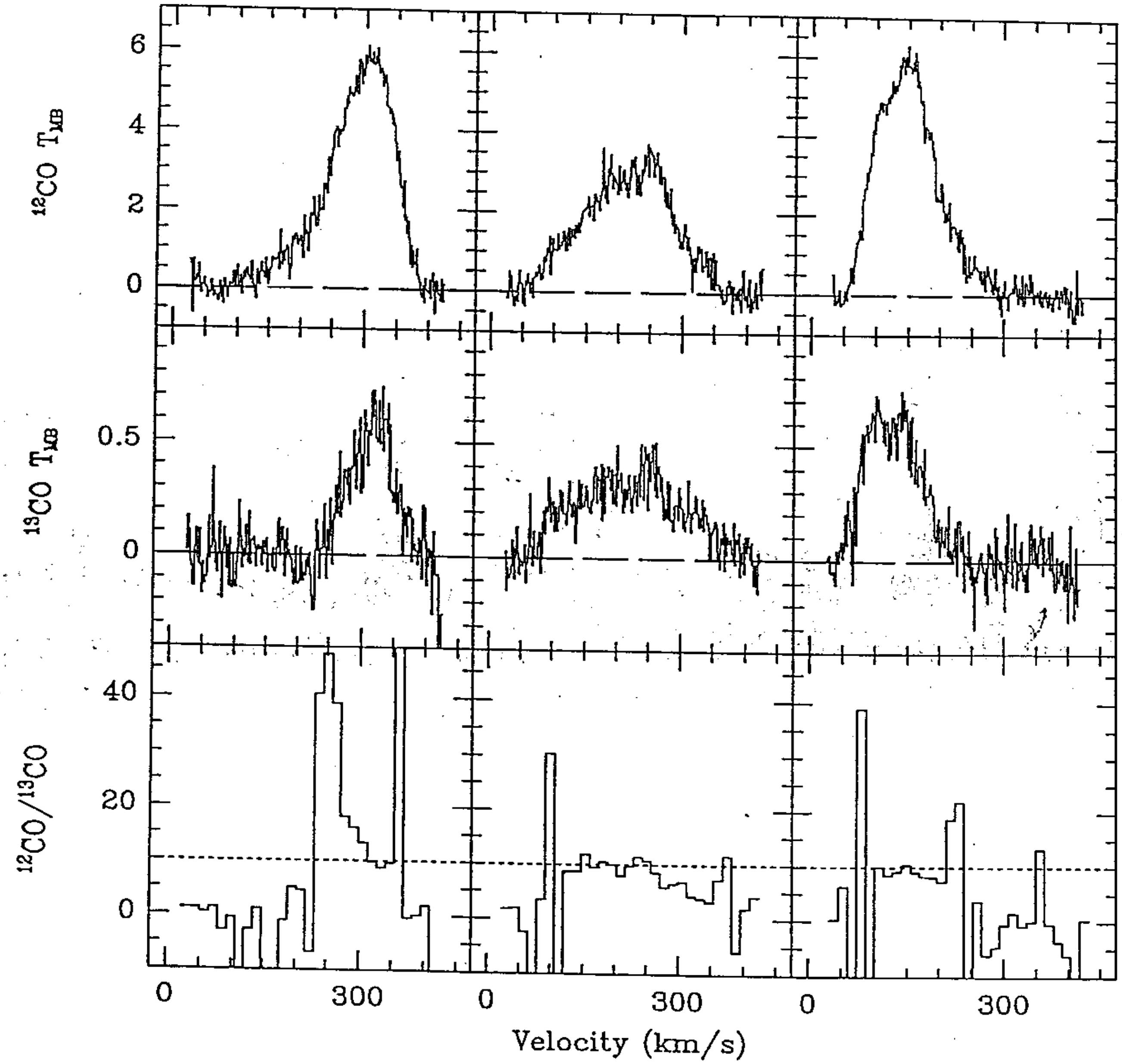


Fig. 2: Spectra of the ^{12}CO and ^{13}CO (3→2) lines and their ratio for the nucleus of M82 and two positions 12″ on either side along the major axis which are coincident with the peaks of the circumnuclear ring.

Table 1
M82: average peak line temperatures

	line	T_{MB} (K)
^{12}CO	(1→0)[a]	4.2 ± .84[c]
	(2→1)[b]	8.3 ± 1.3
	(3→2)	5.0 ± .75
^{13}CO	(1→0)[a,b]	.32 ± .06
	(2→1)[b]	.64 ± .15
	(3→2)	.45 ± .09

[a] Nakai et al. 1987, P.A.S.J. 39, 685.

[b] Loiseau et al. 1990, Astr. Astrophys. 228, 33.

[c] The errors quoted in Table 1 reflect the uncertainty of the overall calibration of the temperature scale at the various telescopes, which is much larger than the uncertainty due to noise and baseline subtraction.

All the parameters are well-constrained by the model. In spite of this, the best fitting set of physical parameters (see above) would give a 2→1/1→0 line ratio of ~ 1 instead of the observed ratio of ~ 2. The reason for this is that the observed ^{12}CO/^{13}CO ratios imply relatively high optical depths, whereas the observed 2→1/1→0 line ratios require the gas to be optically thin. Hence, the data indicate that the molecular medium in M82 is not well represented by a single set of average physical parameters and that a multi-component model may be needed to reproduce all the line ratios in detail.

The above analysis illustrates the importance of higher transition lines, such as the CO (3→2) line, as a clue for physical conditions of the molecular gas and the properties of molecular clouds in external galaxies. A more extensive analysis of the whole data set is in progress.

We thank Bill Danchi, Paul Jaminet, Göran Sandell, and Adrian Russell for their efforts regarding the setup and calibration of the receiver, and their help with these observations. Their contributions together with the excellent support of the telescope operators at the JCMT were crucial for a successful completion of this project. We also thank Lowell Tacconi-Garman and Shuding Xie for the contribution of additional observing time.

Linda Tacconi, Radiosterrenwacht Dwingeloo, The Netherlands
Remo Tilanus, Institute for Astronomy, University of Hawaii
Collaborators: K.Y. Lo (Univ. of Illinois), D.B. Sanders (IfA, Hawaii), S.A. Stephens (Univ. of Illinois), E.C. Sutton (UCLA Berkeley), C.G. Wynn-Williams (IfA, Hawaii), S. Zhou (IfA, Hawaii).

JCMT Users Committee Meeting (26 April 1990, Groningen, Netherlands)

Before reporting, I would like to list good reasons for the existence of the Users Committee. Its members are active JCMT users and their inputs are most valuable to fine tune the immediate operations (Hilo improvements) and mid-term goals (ROE plannings, policies, and priorities). Its members act as a JCMT forum (for instrument builders, for comparisons, for applying pressures, for giving backings). In between meetings, people in operations and plannings endeavour to behave as they think the UC would endorse (otherwise periodic retribution).

(To reduce paperwork and efforts, I would like the UC meeting to happen the **DAY BEFORE** the Board meeting, at the same city and at the same hotel.)

Below is a brief summary of the topics debated, and of the actions recommended.

Various items from the last meeting were detailed:

- No time was lost in the last 6 months because of icing (going out on catwalk at night is dangerous but seldom needed).
- 114 responses for the 3 telescope operators' positions (training will use a library of video tapes).
- A query was made on whether the T.O. could start the telescope earlier (afternoon), so that it is ready when first shift starts.
- Acclimatisation of day team: going from Hilo to summit at 10 am with a 1h acclimatisation is not a problem (staff must be reminded to act slowly when arriving at summit).

Statements on funding situation were made:

- The inflation index for the JCMT tends to be the value which is the lowest in the partner countries (~0% in the Netherlands).
- The bids for extra JCMT funds need to be done at the rate which is the slowest in the partner countries (~3 years in the Netherlands).

Report on Hilo operations:

- Good antenna pointing model: 2.5 arcsec rms.
- Various antenna beam patterns were examined (library of beam maps from UKT14).
- JCMT staffing in Hilo is adequate in numbers (40 positions), but the balance of skills needs retouching - possible with local hirings. More heterodyne receiver skills are needed.
- More PATT Discretionary time for science is requested.

Report on ROE plannings, policies, and priorities:

- A staff member was moved to Hilo, to help operations there (it costs a lot to move someone, and to maintain him/her with fringe benefits).

- Work overload has been felt in Edinburgh (second half of list of priorities pushed aside).
- Some receivers shipped in the past to Hilo required a lot of time there to get them ready to operate. Edinburgh helps with making sure that receivers being built will keep to specs and with ironing out serious problems between labs and Hilo, before receivers are shipped to Hilo.
- PATT TAG may end up writing the feedback letters to JCMT applicants for observing time, due to a shortage of staff members in Edinburgh.

Report on Receivers being built:

- The practice of building an interim test receiver, before building the final common user receiver, was discussed. The necessity of getting feedback at the telescope on the interim receiver was stressed. The view that the interim receiver should be used as a subset of the final common user receiver was expressed.

Report on new Instrumentation Proposals:

- Alberta/HIA: SIS planar array was accepted.
- Interferometry: the collaboration between JCMT and Caltech was accepted. Modest effort, cost split 50% - 50% with Caltech.

Good Weather observing Conditions:

- Maximum science can be had from flexible scheduling. But we need serious information on site quality (transmission, refraction noise, sky noise). One airmass from zenith may give too low a transmission. An individual will be named by Hilo to archive the necessary weather information. Some double scheduling will be attempted.

Remote observing:

- At UKIRT some remote observing will start this summer '90. It will be proven first at UKIRT, then extended to JCMT. This UKIRT work should not compromise JCMT needs in remote observing.

Solar Eclipse of 11 July'91:

- Wide open to all receivers available, and to all wavelengths attainable. Agreed by Univ. of Hawaii, and by JCMT UC.

Network to all JCMT users:

- The Canadian JCMT-L computer network already links by e-mail all Canadians who use the JCMT. It has provided fast, reliable information on hot news concerning the JCMT (don't have to wait for the printed PROTOSTAR every six months).

- The Canadian JCMT-L network has now been extended to link all Dutch JCMT users. It should soon be further extended to include the UK JCMT users, and then the rest of the world using the JCMT.

Next JCMT UC meetings:

- end of Sept.'90, possibly in Cambridge, UK.
- possibly end of March'91, in Ottawa, Canada.

J.P. Vallée
JCMT UC Joint Sec

PATT TAG REPORT

The semester S PATT meeting was held in Swindon on 10-11 July'90.

1. Proposals received for JCMT for Semester S (Sep.'90 to Feb.'91).

Number of Univ. Hawaii proposal	:	10	
Number of PATT proposals with OTH PI	:	15	
Number of PATT proposals with UK PI	:	35	UK/(UK+CAN+NL)=50%
Number of PATT proposals with CDN PI	:	25	CDN/(UK+CAN+NL)=36%
Number of PATT proposals with NL PI	:	10	NL/(UK+CAN+NL)= 14%
		95	

Number of line proposals	:	49	
Number of continuum proposals	:	43	
16-hour nights requested to PATT	:	250	
Nights available for PATT-science	:	127.5	requested/avail.=2.0

2. PATT Awards for JCMT for this semester S:

Number of nights in semester	:	180.0	(no XT observing)
Awarded for Engin. and Commiss.	:	27.0	
Number of nights given to U. Hawaii	:	15.0	
Given for Discret. use	:	10.5	
Nights available for PATT science	:	127.5	requested/avail.=2.0
Service nights	:	0.0	
Number of nights awarded to OTH	:	36.0	OTH/PATT Science= 28%
Number of nights awarded to UK	:	46.2	UK/(UK+CAN+NL) =50.5%
Number of nights awarded to CAN	:	26.6	CAN/(UK+CAN+NL)=29.1%
Number of nights awarded to NL	:	18.7	NL/(UK+CAN+NL) =20.4%

3. Trends for Hilo's Engineering, Commissioning, and Discretionary Time: The percentage of semester time allocated for Engin. plus Commiss. plus Discretion. uses are, for JCMT and UKIRT:

Semester	M	N	O	P	Q	R	S
JCMT	51%	34%	40%	37%	35%	29%	21%
UKIRT	12%	12%	12%	12%	10%	13%	18%

4. Distribution of JCMT PATT proposals by scientifc categories:

Sun and solar system	:	5/85 = 6%
Stellar	:	18/85 = 21%
Galactic HII and cloud edges	:	7/85 = 8%
Galactic clouds	:	23/85 = 27%
Galactic outflows and disks	:	13/85 = 15%
Galactic SNR, cirrus, etc	:	3/85 = 4%
Extragalactic	:	16/85 = 19%
		100%

5. Service Observing:

The Hilo team for the JCMT will carry out service observing for 2 short proposals (each awarded 1 shift).

Canada offered to do some service observing, by having the Herzberg Institute astronomers in Ottawa already going observing in Hawaii on regular observing trips, to stay on for some extra shifts in order to carry out service observing for Canadian university astronomers (short allocations only). It was decided to consider this possibility for the other two participating countries.

6. Some comments on the JCMT PATT TAG efforts:

All JCMT proposals will continue to be refereed for scientific merit. All JCMT proposals will continue to be checked by Hilo for technicalities. All JCMT proposals will continue to be graded by 6 assessors.

In semester S, 59 out of 85 PATT proposals got JCMT time (= 69 %), so the average JCMT time award is 4 shifts (255 shifts/59 proposals).

Starting with semester S, the feedback letters for all JCMT proposals are now drafted by the first assessors (instead of the Tech Sec). They are checked as usual by the JCMT TAG chairperson, then are sent to Swindon for mailing.

This semester was the ending of 3-year terms for 2 JCMT PATT assessors: Richard Hills and Mike Fich.

Matt Griffin will become the new JCMT PATT TAG chairperson, and Ms. Ewine van Dishoeck will join the group of JCMT assessors.

7. Some comments on the SERC-Swindon efforts:

Attempts by Swindon to create a new "observing run" form, to be completed about 2 months after coming back from a PATT telescope, were rejected by the members of all the TAGs.

Attempts by Swindon to create a new "absolute" grading system of all PATT proposals were received with mixed feelings. It was agreed:

- to grade from 6=low to 1=high;
- to weight equally all grades;
- to carry on with correcting the mean of each assessor's grades (=3.5).

After the PATT TAG meeting, it was agreed:

- to transfer the final grades (relative scale) to SERC's "absolute" scale.

The next PATT-Tec Sec meeting is in London on 23 Oct.'90.

The next PATT meeting is in Swindon on 13-14 Dec.'90.

J.P. Vallée
JCMT-PATT Tec Sec

Note from the Chairman of the JCMT TAG.

As usual we introduced a few new twists into the business of allocating time and scheduling the telescope for semester S. The main points are a first step in the direction of flexible scheduling and an intermingling of calibration and performance measurements with observing. The purpose of both these are to try to improve the quality of the data coming out of the telescope and, as explained below, the main effect for observers is that in some cases the actual periods of telescope time scheduled for their observations may exceed the allocations made by PATT.

All those who have tried to make observations at frequencies higher than about 400 GHz are well aware of the frustrations caused by the fact that conditions are only good enough for this about a third of the time. Clearly what is needed is a means of ensuring that the times with the best conditions are used for the high frequncy work and that good lower frequency observations are carried out when the sky is wetter. To go to fully flexible scheduling would be costly in people's time and will probably only be possible if remote observing can be made to work. Some flexibility is of course already provided by the individual observing groups having their own backup projects. The way in which it is proposed to introduce a further element of flexibility in semester S is by putting together some pairs of proposals - one high frequency and one low - and scheduling them for a single block of time equal to the sum of their allocations. The high frequency observer will then have to make a decision at the beginning of each shift (say by 6 pm or 2 am), based on whatever information is available - sky emission, humidity, cloud, the CSO monitor, etc - as to whether to take the shift. This would continue until either one of the programmes had used all its allocated shifts and the remaining nights would then default to the other one. The main implications are that observers will have to stay out at the telescope for longer and they will be contacted by JACH to ensure that they are willing to do this.

The second point will affect more people. Efforts have been going on for some time to obtain information about beam shapes, efficiencies, pointing and so on. These have been generally been carried out in scheduled AIC time but progress has been painfully slow, mainly due to bad weather. Since in many cases the measurements do not need to take very much time but do need good conditions and for everything to be working well, it is proposed that the support scientist will carry out such measurements from time to time during PATT scheduled observations. To compensate the observers an extra shift may be added to some allocations. It is not clear that this will come out giving justice to everybody but the point is that this information is of benefit to all users and so community participation is appropriate. One particular thing that will be requested of UKT14 observers is to make "sky-dip" measurements a couple of times a night, in order to provide information on the uniformity of the atmosphere.

Good luck!

Richard Hills, MRAO
with Richard Wade, JACH

JCMT Scientific Time Allocations for SEMESTER S (Sept.'90 to Feb.'91): (in 8hour-shifts)

To save space only the name of the PI is given.

Taylor, A.R. Mapping of circumnebular CO in the young planetary nebula NGC7027 (4 shifts).

Rucinski, S.M. Structure of the Rho Ophiochi B1 core (3).

Mitchell, G.F. Study of Hot gas toward 3 young stellar objects (3).

Thum, C. Hydrogen recombination line masers (3).

Heiles, C. Submillimeter continuum observations of infrared cirrus point sources (3).

Crawford, I.A. Spatial Resolution study of the diffuse cloud toward HD26571 (2).

Friberg, P. Outflow structure in L1551 (2).

Friberg, P. Column density structure around the HII region RCW38 (1).

Matthews, H. Physical conditions in Herbig-Haro flows (5).

Matthews, H. Investigation of the collimating disks around Herbig-Haro objects (3).

van der Hucht, K.A. Nonthermal emission and ionisation structure of Gamma Vel (WC8+091) and EZ CMa (WN5) (1).

Braun, R. Interstellar media of nearby galaxies (6).

Israel, F. CO in northern galaxy nuclei (8).

van der Kruit, P.C. Arm/interarm star formation efficiency ratios in grand design spirals: CO in NGC3631 (7).

Clark, T.A. Investig. of solar submillimeter hydrogen recombination lines from n=20-19 and 22-21 (4 days = 4 shifts).

Naylor, D.A. Far Infrared Spectroscopy of Jupiter and Mars (4).

Roche, P.F. Search for cold dust in galaxies (1).

Macdonald, G. Search for true protostars (4).

Skinner, S.L. Millimeter continuum emission in Herbig Ae/Be stars (6).

Mullan, D.J. Submillimeter continuum emission from flare stars (3).

Little, L.T. HCO^+ in the cores of HH24-27 and GGD12-15 (3).

Dent, W.R. CI observations of the ambient gas in HH2 (3).

Gear, W.K. Small-scale high-velocity gas in Taurus (3).

Gear, W.K. Nature of very young outflow sources in Taurus (3).

Baas, F. Chemistry of stellar winds from low-mass pms objects (3).

Baas, F. Continuum and line mapping of IRS1, IRS9 and IRS11 in NGC7538 (3).

Hu, J.Y. Determination of the onset of a fast wind in protoplanetary nebulae (3).

de Jong, T. Relative contribution of silicon carbide and amorphous carbon in the envelopes of carbon stars (3).

Emerson, J.P. Determination of the masses of T Tauri star disks (4).

Ward-Thompson, D. Luminosity and dust mass of the outflow-driving source VLA1623 (4).

Hughes, D.H. Submillimetre photometry of radio quiet quasars (8).

Brown, A. Remnant circumstellar disks around naked T-Tauri stars (3).

Rogers, C. High Resolution study of B361 (8).

Bastien, P. Structure and mass of dense protostellar condensations (4).

Harris, A.I. Submillimeter CO emission from warm and dense gas in 2 external galaxies (10).

Russell, A.P. ^{13}CO and ^{12}CO observations of outflow sources (5).

Russell, A.P. Spectral line contamination and true dust emissivity in molecular clouds (4).

Graf, U.U. Isotopic CO J=6-5 study of star forming regions (5).

Fich, M. Dust emission from the elliptical galaxy NGC 205 (2).

Fich, M. Star formation conditions around small nearby HII regions (4).

Fich, M.Nature of S266 (3).

Davies, R.D. Millimetre wave emission from IRAS cirrus clouds (4).

Robson, E.I. Diffraction limited 350/450 mapping of NGC2071 (3).

MacLeod, J.M.Search for ^{16}O^{18}O in Orion (N1) (5).

Redman, R.O. Submm continuum spectra of igneous asteroids (4).

Redman, R.O. Submm continuum observations of the Moon (4).

Tacconi, L.J. Spiral Structure of NGC 6946 (6).

Coleman, P.H. Low frequency cutoffs in the spectra of radio quiet quasars (8).

Hills, R.E. Rotation curves of high-density molecular cloud cores (4).

White, G. CO J=4-3 mapping of Orion (3).

Padman, R. CO J=4-3 studies of molecular jets and outflows (6).

White, G. CI $^3P_1$-$^3P_0$ mapping of Orion (6).

Williams, P.G. Effects of fragmentation on photo-dissociation region chemistry in S140 and M17SW (6).

Barsony, M. Accretion luminosity problem in protostars (3).

Barvainis, R. 800um polarimetry II: a survey of star forming cores (10).

Quenby, J.J. Observations of continuum emission at mm and submm wavelengths in normal galaxies (4).

Wannier, P.G. Warm neutral halos around molecular clouds: continuum emission (2).

Feldman, P.A. Search for the Hydrogen molecular ion $H2^+$ (3).

Stacey, G.J. Follow up submillimeter CO observations of HH objects (5).

Sanders, D. Submillimeter continuum observations of Optical and Infrared quasars (5).

Jewitt, D. Lifetimes of circumstellar disks (7).

Sanders, D. CO 3-2 observations of a complete set of starburst nuclei (2).

Zhou, S. Measuring disk sizes around T Tauri stars (4).

Becklin, E. Dusty disks around stars in the Pleiades? (5).

Lindsey, C. Submillimeter observations of sunspots and plage in 850 microns and 1.3cm from the JCMT and the VLA (5).

APPLICATIONS FOR TELESCOPE TIME: ARRANGEMENTS FOR SEMESTER T

For Semester T (March 1991 - August 1991) the closing date for applications will be September 30, 1990. Postal applications should be sent to:

The Executive Secretary, PATT
SERC
Polaris House
North Star Avenue
SWINDON SN2 1ET
U.K.

Enquiries may be made by telephone (0793 411198) or e-mail SMJM0@UK.AC.RL.IB.

Application forms may be obtained from the above address, as also may sets of Notes for the Guidance of Applicants. Those who have not previously applied for telescope time on SERC telescopes are strongly advised to obtain copies of these Notes. In North America copies of the application forms can also be obtained from:

Dr J.M. MacLeod
Radio Astronomy Section
Herzberg Institute of Astrophysics
100 Sussex Drive
Ottawa, Ontario K1A 0R6
Canada
(613-993-6539)
e-mail JOHNM@HIARAS.NRC.CA

The new application form attached to the September 1989 issue of this Newsletter should be used.

Please make sure that you included the full RA and Dec of your sources.

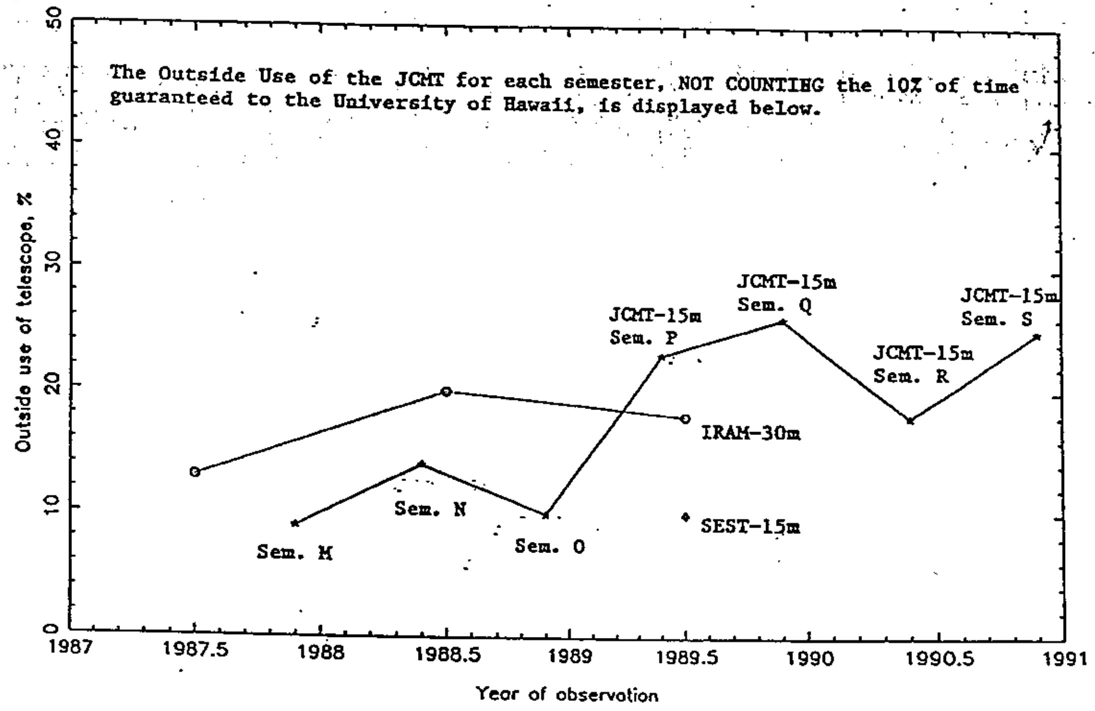
All applications will be refereed as usual and graded by assessors.

Applications are invited from outwith the JCMT partner countries. As the graph below shows, a significant share of telescope time is frequently awarded to such applications; comparative figures for IRAM and SEST are added for interest.

Papers based on data obtained at the JCMT should carry an acknowledgement or a footnote mentioning "The James Clerk Maxwell Telescope is operated by the Royal Observatory Edinburgh on behalf of the Science and Engineering Research Council of the United Kingdom, the Netherlands Organisation for Scientific Research and the National Research Council of Canada".

Please send a preprint copy to S.J. Bell Burnell (ROE, Edinburgh).

J.P. Vallée
JCMT-ROE



RECEIVER NEWS

The following instruments should be available to users on the JCMT during semester T (March 1991 - August 1991)

Heterodyne (spectral line) receivers:

The band 220 - 280 GHz: receivers A1, A2

Receiver A1 nominally covers the frequency range 220 - 280 GHz. Two mixer sets are used to achieve this range: A1(lower) operates well up to 245 GHz, while A1(upper) is better at frequencies above 245 GHz. Frequencies somewhat outside this range may be accessible with some degradation of performance. Two Gunn oscillators are required presently to cover the upper band. Receiver A1 is a dual-channel device, and thus is receptive to both polarizations. However, for the most of the last two years Receiver A1 has been operated in a 'hybrid' mode, i.e. with one mixer from each frequency range. Although this mode offers flexibility with minimum risk to the equipment, observations are possible in only one frequency band at a given time, and thus only single polarization observations can be accommodated. This situation is likely to continue through semester T. A single-sideband filter should be available for those users requiring rejection of the image sideband; it should be specifically requested in the proposal.

Modifications to the A1 cryostat have recently been carried out at the JCMT by Bob Barker from MRAO and Hugh Gibson. Bench tests show that the lower band now has the best performance it has ever had (305 K DSB has been measured). On the telescope, typical double sideband receiver temperatures at the band centres are 350 K and 650 K for the lower and upper bands respectively, corresponding to single sideband system temperatures of about 900 and 1600 K respectively in the best cases. Receiver temperatures increase with distance from the band centres; at 272 GHz and above receiver temperatures can be 1000 K and greater.

New HEMT IF amplifiers have also been incorporated into the system. The result has been a considerably flatter bandpass response, and in turn, a narrower region of high noise at the end of the AOS bandpass.

Receiver A2 is expected to arrive in Hawaii during semester T, in April 1991. Once it has completed commissioning on the telescope, it will likely be available on a best efforts basis to users during the semester. However, no specific requests for its use in this period can be entertained, and no firm values for its performance can be quoted at this stage.

320 - 370 GHz: receivers B1, B2 and B3.

The single channel (polarization) Schottky-mixer receiver B1 remains in use at the JCMT. However, during semester S, two new receivers covering this range should be commissioned in October and November respectively: B2, a common-user dual-channel Schottky mixer system being built by MRAO and RAL, and B3, an interim single-channel SIS receiver developed by the HIA/Kent/RAL consortium. Both groups are hopeful to make the new deadlines, but until the receivers have been commissioned at the JCMT, we cannot promise their availability in semester T, and users should not assume in their proposals that this will be the case. The SIS receiver will in any case be made available on a best-efforts basis, and until receiver B2 is fully commissioned, B1 will be retained as the backup.

Receiver B1 has continued to have serious problems, in addition to being somewhat noisy by today's standards. Two carcinotrons are being used, one to cover the higher frequencies, and one for the lower range. Neither work to their original specifications any longer. If all is working well, the lower frequency limit of the receiver is about 326 GHz and it has been used at frequencies as high as 372 GHz, where the limiting factor is the atmosphere, due to an absorption band around 373 GHz. Typical double-sideband receiver temperatures, after optimum tuning, at the band centre are about 950 K, and may be somewhat better in places, corresponding to single sideband system temperatures of about 2800 K under good conditions, increasing away from the band centre.

Receiver B2 is scheduled to be commissioned at the JCMT in October 1990. Recently, good results have been reported for the mixer performance (the best value obtained is 340 K DSB receiver temperature). For the moment, if one were to conservatively assume a tuning range of 330 to 360 GHz, with a receiver temperature of 700 K, one would probably err on the safe side.

Tests of a 245-GHz prototype SIS receiver in May 1989 proved very successful; some of the hardware for this receiver forms part of the 345-GHz SIS receiver (B3). Again, no firm information on tuning range and receiver temperature will be available until after the scheduled commissioning run at the JCMT in November 1990. The design goal is to achieve a receiver temperature of 300 K (DSB) across the 330 - 360 GHz band.

460 - 490 GHz; receiver C1.

Receiver C1 is a heterodyne receiver for the 450 to 500 GHz waveband, using InSb 'hot electron' bolometers as mixers. Because of the finite time constant of this form of mixing, the practical single-sideband IF bandwidth is a little less than 1.5 MHz. It is therefore necessary to 'sweep' the local oscillator frequency across the line to obtain a spectrum. This leads to the major consideration when planning observations with this type of receiver: if one observes a spectrum covering n channels the effective system temperature will be be increased by the factor sqrt(n). Since the mixers respond to both sidebands the normal resolution is somewhat less than 3 MHz (about 2.6 km/sec), but higher resolutions can be obtained by switching in filters (with double-sideband widths between 500 kHz and 4 MHz) in the IF chain. Two mixers, sensitive to orthogonal linear polarizations, are provided.

Receiver C1 underwent extensive commissioning tests during June and November 1989. As a result of these tests, the Joint Astronomy Centre has accepted the receiver for astronomical observations during semester S, in a strictly limited sense until further notice: only CO J=4-3 (461.04 GHz) and neutral carbon $^3P_1$-$^3P_0$ (492.16 GHz) observations can be accommodated. The standing waves which plagued the earliest observations have been essentially eliminated and mixer improvement at 492 GHz realised, and further work to complete the receiver will be carried out during semester S (probably January). Observers should be aware that although the operation of C1 is straightforward, the atmosphere prevents useful observations for more than one-half of the time on average, so that users should be prepared with a suitable backup programme. Typical receiver temperatures are 500 K at 461 GHz, and about 700 K at 492 GHz. This leads to total system temperatures, after accounting for atmospheric and telescope losses, of (very) approximately 7000 and 10000 K per channel.

The 690 and 800 GHz windows: Receiver 'G'

Thanks to the continuing arrangement with Reinhard Genzel and his group at the Institut fuer extraterrestrische Physik in Garching, it is likely that Receiver G will be offered once again for users in Semester T. Interested users should contact either Prof. R. Genzel or Dr. A. Harris to arrange collaborative efforts. As described in 'Protostar' (Sept. 1988) the instrument is largely self-contained. Because LO power is provided by an infrared-pumped laser, only certain discrete frequencies can be accessed, in the regions around the CO J=6-5 and 7-6 lines at about 690 and 800 GHz respectively. Three laser lines are used commonly: $^{15}NH_3$ (802.986 GHz), HCOOH (692.951 GHz) and CH_3I (670.463 GHz). Other possibilities are available, and individuals wishing to observe at other frequencies should first check with the MPE group. In the 800 GHz region, the HCN and HCO^+ (J=9-8) lines can be observed, along with the neutral carbon ($^3P_2$-$^3P_1$) transition. It is useful to note that the J=6-5 transition of CO is much easier to detect than the CO(7-6) line, since the telescope is considerably more efficient at the lower frequency. In general the IF bandwidth is about 1 GHz, with coverage in the IF between 1 and 10 GHz, with some gaps. Two 'on-board' 500 MHz AOS's, having spectral resolutions of 1 MHz are provided.

Receiver G is mounted on the right Nasmyth platform of the JCMT. Typical double sideband receiver temperatures range from 3000 through 4500 K; specifically, at CO(6-5) and ^{13}CO(6-5) receiver temperatures of 3000 and 3500 K are obtained. The resulting single-sideband system temperatures are extremely sensitive to atmospheric conditions, but are likely to be of the order of 55000 K or more, under practical conditions. It is likely that a period of about one month (July?) in semester T will be set aside specifically for observations with Receiver G; interested users should develop proposals with this in mind, and be aware that a low-frequency back-up proposal requesting no time (Protostar, Sept. 1989, p. 12) is also required.

Spectrometer Backends

During semester T the AOSC (an acousto-optical spectrometer which offers a resolution of about 330 kHz and a total bandwidth of 500 MHz) will continue to provide the main spectrometer capability at the JCMT. Developments to the microcomputer code have lead to the routine use of spectral line observing using the chopping secondary mirror. The use of this technique shows a major improvement to baselines and a reduction in sky contributions to the noise level, which are particularly evident in the 320 - 370 GHz window.

The Dwingeloo Autocorrelation Spectrometer (DAS) will provide considerably expanded capabilities in terms of frequency resolution and IF configuration. It is scheduled to be commissioned at the JCMT in April-May 1991, and may be offered to users during the latter part of semester T. The DAS has 2048 delay channels, divided into 16 analogue section each 125 MHz wide, and having a total maximum bandwidth of 2 GHz. It will be capable of accepting up to eight IF inputs, with spectral resolutions of between 0.1 and 1.0 MHz.

Approximate rms sensitivities after 30 minutes' integration (spectral line)

Below is a table of the calculated rms noise in Kelvin after a total observation time of 30 minutes (this assumes 15 minutes on source, 15 minutes on a reference position), for three different values of the atmospheric transmission. There have been requests to provide a tabulation of measured results obtained during actual observing runs. Unfortunately, the tabulation would then neither be complete nor consistent, since the available information has been taken under a wide range of conditions. However, it is my experience that the values listed represent what is actually observed; indeed, one finds for the cases that I have tried that the noise on a given spectrum usually accurately reflects the assumed system temperature. It is also my experience that the rms noise decreases as the square root of the total integration time except in pathological cases.

The rms noise values also scale directly with system temperature, and thus are critically dependent on atmospheric conditions. The system temperatures and rms noise quoted should be achieved under 'typical' conditions (approximately 1.5mm of water vapour), and will rise rapidly as the weather worsens. In parentheses, the expected values of the rms noise are given for 'exceptional' and 'poor' weather conditions (about 0.5 and 5 mm of water vapour respectively). Although these numbers should be taken as a guide only, it is clear immediately from this table that atmospheric conditions affect receiver B, C and G observations strongly, and poor conditions render work at the higher frequencies impossible. One should always have a contingency plan, in case of uncooperative weather.

Frequency (GHz)	**Receiver**	**T(rx) (K)**	**T(sys) (K)**	**Resolution (MHz)**	**Rms noise (K)**	**Notes**
230	A1(lower)	350	960	0.33	0.08 (0.07,0.11)	
270	A1(upper)	1000	2490	0.33	0.20 (0.19,0.25)	
345	B1	950	2990	0.33	0.25 (0.20,0.49)	
362	B1	1000	3880	0.33	0.32 (0.23,0.84)	
461	C1	500	46300	3.00	1.26 (0.41, *)	1,2
492	C1	700	77900	3.00	2.12 (0.74, *)	1,2
690	G	3000	48300	1.00	2.28 (0.97, *)	2
810	G	4000	78800	1.00	3.71 (1.43, *)	2

Notes:

(1) This assumes a total of 50 channels in the spectrum and 1 MHz filter "channels"; narrower resolutions are available (see above).

(2) An '*' means that observations are not possible when conditions are 'poor'; the rms noise is effectively infinite.

One should include overheads for 'dead' time during observations. Although it depends on the efficiency of the observing technique used and the relative positions of sources in the program, in general one can expect to spend of the order of 25% more time in telescope movement and software overheads. Observations made in a beam-switched mode seem to require somewhat higher overheads. Additonal time is required for careful pointing and focus meaurements, particularly in early evening and after dawn.

Continuum Observations:

UKT14

The UKT14 bolometer system will be available in Semester T with the standard full range of filters to permit observations at 2, 1.4, 1.1, 0.85, 0.8, 0.6, 0.45 and 0.35 mm. Sensitivities (in terms of NEFD - noise-equivalent flux density) range from typically 0.2 Jy/sqrt(Hz) at the longer wavelengths, through to 10 Jy/sqrt(Hz) or more at the highest frequencies under good photometric conditions. Only about 30% of all nights allow one to achieve meaningful results at 450 and 350 microns, however. The properties of UKT14 using the various available filters and apertures are given in the following table:

Filter (mm)	**Wavelength** (micron)	**Centre Freq.** (GHz)	**Bandwidth** (GHz)	**Aperture** (mm)	**Beamwidth** (arcsec)	**NEFD** Jy/sqrt(Hz)
2.0	2000	150	40	65	28	approx. 2
1.3	1300	233	64	65	21	0.1 - 0.5
1.1	1100	264	75	65	19	0.3 - 0.5
0.85	850	354	30	47	16	0.8 - 1.5
0.8	761	394	103	47	14	0.5 - 1.0
0.6	625	480	119	36	9	not avail.
0.45	438	685	84	27	7	> 5
0.35	345	870	249	21	6	> 10

The dominant contribution to the noise in a UKT14 measurement originates from the atmosphere, and since this most definitely does not obey gaussian statistics, there is a time in every longer integration after which the noise level will not decrease. That is, it is not just the transmission of the atmosphere which influences the signal/noise ratio, but the major effect is correlated noise due to atmospheric microstructure. The degree of atmospheric instability is reflected in the time beyond which the signal/noise ratio does not improve. Furthermore atmospheric stability does not appear to be correlated with improved transmission. Thus it is difficult to provide further guidance to the user on the effect of differing atmospheric conditions. What is usually done to combat this effect is combine a number of short (say 5 minutes each) measurements, rather than one longer one, and derive the mean flux density and standard deviation from the set of signals. The length of each integration will be judged from the atmospheric conditions at the time of the observations. In making continuum photometry and mapping observations, the careful observer will spend a significant amount of time in frequent calibration measurements. This time is to be added to the 25% or so which should ordinarily be added to allow for telescope movement and so forth. The actual 'astronomical' overhead will depend on the program goals and source strengths, and may range from about 20% extra up to 80% or more in the most extreme cases.

UKT14 polarimeter

Successful commissioning tests by Alistair Flett and Sy Murray of the Aberdeen/QMW polarimeter attached to UKT14 took place recently at the JCMT. As a result, the instrument has been released for use in step and integrate mode (i.e., photometry is performed at each of a number of waveplate position angles).

The effective NEFD of the polarimeter/UKT14 combination is NEFD(p) = 2xNEFD/P, where P is the degree of polarization of the source. The additional factor of 2 arises because one polarization only is detected. Thus, for example, the detection of the polarized signal from a 20% polarized source will take (2/0.2) squared = 100 times longer than the detection of the unpolarized object using UKT14 alone. In addition, the polarimeter is subject to all the problems resulting from atmospheric noise that afflict UKT14 measurements.

A Note on Telescope Performance

The last round of adjustments of the telescope surface late in 1989 have lead to a mean surface rms accuracy over the whole 15-m diameter of the JCMT which now seems to be as good as 30 microns. For this figure, at the longest wavelengths (using, say, Receiver A1), the beamwidth and beam efficiency are about 21 arcsec and 0.80 respectively, at 460 GHz the corresponding numbers are about 11 arcsec and 0.62, while at the highest frequencies in use (around 800 GHz) they fall to 6 arcsec and 0.28.

The rms pointing errors are slightly better than 2 arcsec in both azimuth and elevation; because of the increasing use of the JCMT at higher frequencies, effort will continue to go into reducing these errors still further in the near future when test time is available. The next major effort will be devoted to understanding the effects of temperature on pointing, focussing, and telescope efficiency.

Henry Matthews
JACH

PERSONNEL

Saeko Hayashi takes up a new post in Tokyo

Saeko Suzuki Hayashi left the JCMT group in Hawaii in May to return to Tokyo, where she has taken up a post with the Japan National Large Telescope. Saeko has been a Research Fellow and Support Scientist with the JCMT since 1986, with particular responsibilities for the holographic measurement of the dish and for adjusting the surface.

Her contributions to the life of the Joint Astronomy Centre have been many and varied, from showing Japanese dignitaries round the observatory to denting a Western myth about the submissive nature of Japanese women. One special contribution goes right back to the early days of the JCMT, when we had users on the telescope long before it was ready for them and we were lucky if no more than half a dozen major things went wrong each night. A computerised fault-reporting system had been devised which rapidly and efficiently distributed the bad news each day and was a steady source of gloom until, one morning, a report came down it complaining of a glemlin in the software. This delightful word was quickly taken up and for weeks there were no more snags, bugs or menehune (the Hawaiian equivalent), only glemlins everywhere; for what more felicitous infelicity could there be than a gremlin with a gremlin within?

As well as working all the hours there are in her support role, Saeko carried out a substantial programme of observational research, at the JCMT, the UKIRT and the telescope in Nobeyama. This covered an impressive range of topics, including studies of CO in Cepheus A, rare isotopes of HCO^+ in ρ Ophiuchi, infrared reflection nebulae, the separation of thermally- and fluorescently-excited H_2, and the Universe's only known bi-polar nebula.

Our sadness that Saeko has left is tempered by the knowledge that she will one day return to Hawaii to work as a support scientist on the JNLT. Until then, a warm aloha, sayonara, and all the very best to Saeko in her new career.

Adrian Webster

Wil van der Veen

In September Wil van der Veen will leave Hawaii for a job and change of marital status in New York. Wil has spent the last five months at JACH on secondment from the JCMT Section at ROE where his duties included liaison with the Dutch community and secretary to the JCMT Users Committee. Wil's outgoing personality and unfailing good humour have made him a popular colleague. We thank him for his efforts in promoting the JCMT and wish him well in his future career. Onze Hartelijk Groeten.

Other recent or pending changes affecting the JCMT Section at ROE are as follows:

Alistair Glasse has transferred to T&C Division at ROE to become Project Scientist for a new receiver to be built for UKIRT.

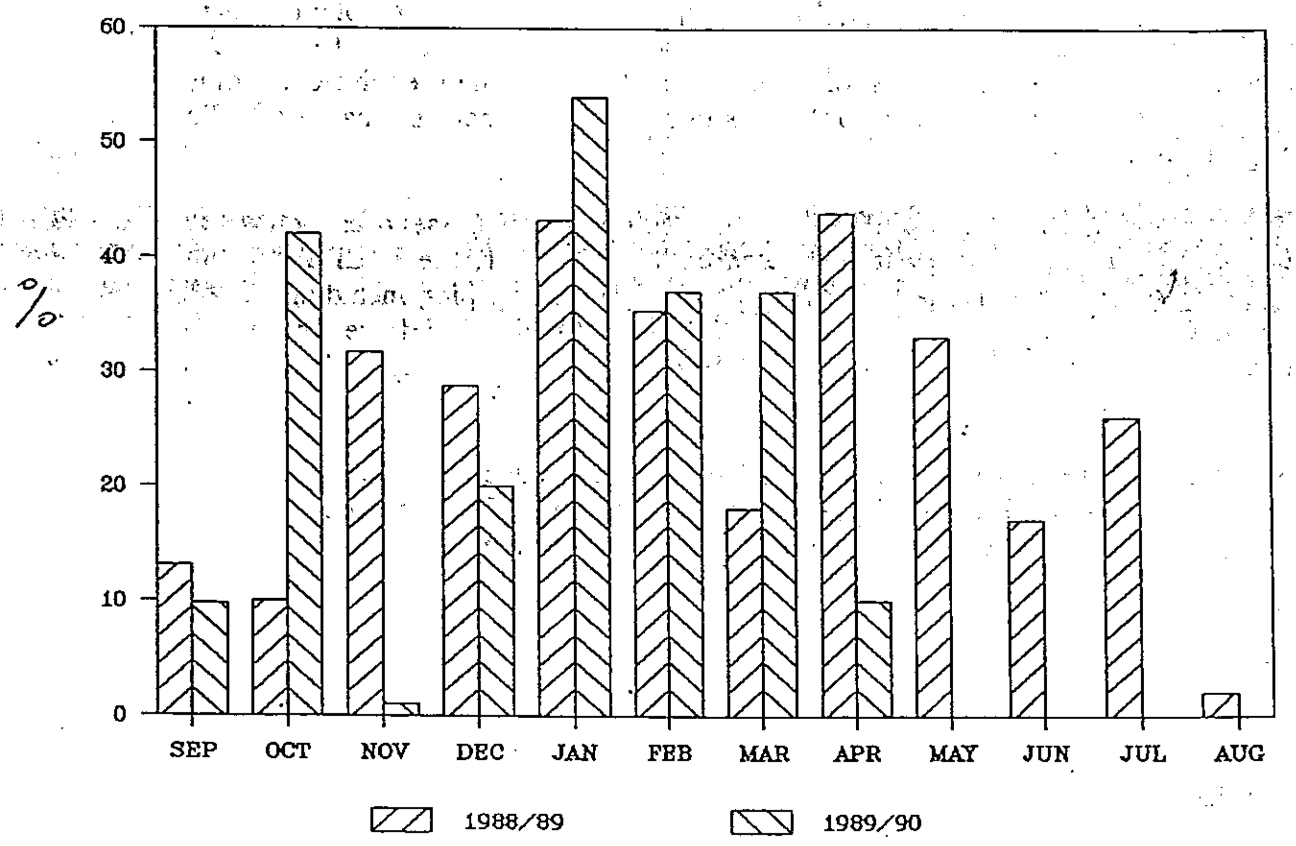
Bill Dent will move to JACH (whence he came) later in the year.

Ko Hummel, at present at Jodrell Bank, will join ROE at the end of the year.

Alex McLachlan

LIES, DAMNED LIES, and .... WEATHER STATISTICS

The following graph is based on information extracted from various reports and is presented without comment.



Percentage of JCMT observing time lost due to weather each month from September 1988 to April 1990.

Alex McLachlan

DIARY

September 30, 1990:	Last date for receipt by PATT of applications for Semester T (March 1991-August 1991)

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