PROTO STAR

The NEWSLETTER of the

JAMES CLERK MAXWELL

TELESCOPE

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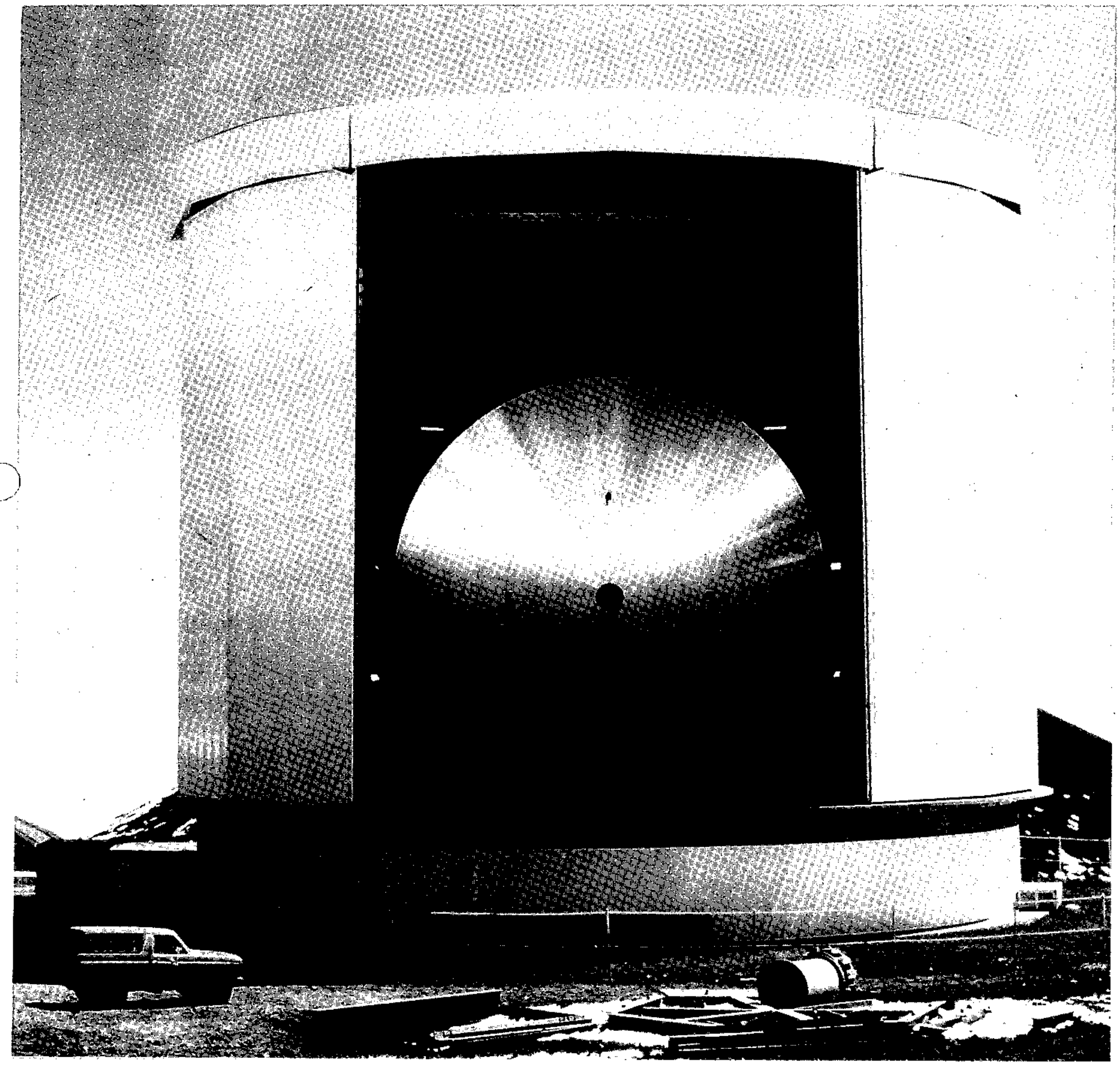

The front page of the previous issue of PROTOSTAR carried a photograph of the JCMT carousel with the membrane in position. The above photograph reveals the telescope that the membrane protects. At the time of the photograph the quadrapod that supports the secondary mirror was not in place.

FOREWORD

One significant event in the commissioning of the JCMT has occurred and another is about to take place. On December 4, 1986 "first light" was acquired. While the expression is rather inaccurately applied to a non-optical telescope it is a convention to describe in this way the first use of a new instrument as an astronomical telescope irrespective of type. For all concerned it represents the culmination of years of intensive effort and on Mauna Kea it is one of the few occasions when the strict rules against the imbibing of alcoholic beverages, effervescent or otherwise, are relaxed (i.e. disregarded).

On April 27, 1987 the formal opening of the JCMT will be performed by His Royal Highness The Prince Philip, Duke of Edinburgh. Among those invited to attend the ceremony are senior members of the Dutch Government. After the ceremony commissioning of the telescope will continue until July 1, 1987, when the Royal Observatory, Edinburgh assumes responsibility for the operational phase.

A NEW EPOCH FOR UK AND NETHERLANDS ASTRONOMERS

The formal opening of the James Clerk Maxwell Telescope by the Duke of Edinburgh on 27 April 1987 will open up a new epoch in UK and Netherlands astronomy. Up till now, millimetre and sub-millimetre astronomy have either been undertaken on foreign millimetre telescopes or else have been made with the UK Infrared Telescope. Now, UK and Netherlands astronomers will not only have a telescope dedicated to these relatively unexplored wavebands, they will also have the largest telescope in the world for these studies. The scientific opportunities are enormous because the telescope and its instrumentation have been delivered on schedule and there will be a unique opportunity to undertake much of the pioneering work which still has to be done. It is important to stress that the sub-millimetre waveband, in particular, is ripe for exploitation. It will be important to investigate the submillimetre properties of many classes of objects which might not appear at first sight to be likely candidates for detection at submillimetre wavelengths. The IRAS survey has indicated the richness of the sky at far infrared wavelengths and it is to be expected that the sub-millimetre wavebands will contain a similar wealth of new science.

Of particular interest is the contribution that the sub-millimetre observations will make to multi-waveband studies. The JCMT fits naturally into the suite of facilities which have been developed for the study of the skies from centimetre to near infrared wavelengths. The UK Infrared Telescope is the most powerful facility in the world for studies in the infrared wavebands from 1 to 30 μm; the IRAS survey has filled in the picture of the sky in the key wavelength region 20 to 100 μm; the UK and Netherlands radio telescopes provide information about sources at centimetre and longer wavelengths; the next major ESA astronomy project will be the Infrared Space Observatory dedicated to the 5 to 100 μm waveband. Thus, UK and Netherlands astronomers have an ideal opportunity for undertaking much of the fundamental science waiting to be undertaken in these "cool" regions of the spectrum.

The project would not have been possible without the dedicated efforts of many individuals. Special credit must be accorded to Richard Hills who has been project scientist for the project since its inception in the early 1970s. The project has evolved considerably since that early time but, through his guidance and that of the Users' Committee, a telescope has been constructed which will cater fully for the demands not only of astronomers of the late 1980s but also for the decades ahead. The success of the construction phase of the project is a great tribute to the management and technical skills of the members of the Rutherford-Appleton Laboratory under the project management of Ron Newport. The project would have been very demanding even if the telescope were to operate at sea level. The fact that the site is at 4,200 m in Hawaii made the project that much more difficult and challenging. I would also like to acknowledge the support of the Scientific Committees and the staff of the Central Office of the SERC. The last five years have been difficult times for the Committees and the Central Office. In particular, the Central Office has given the project as much support as it could and the fact that the project is completed more or less on time is a tribute to their very positive support. In the later stages, the UKIRT staff in Hawaii have been playing a more and more important role as we approach the operational phase. We now have in post the complement of staff needed for the early operational phase of the project. The challenge will be to maintain the high level of performance through into the full operational phase of the project. We will do everything in our power to ensure that the productivity of the telesope and the service to users match the outstanding quality of the instrument.

Malcolm Longair.

RECENT PROGRESS ON "THE MOUNTAIN"

Thus far most of the work at the telescope has been of an engineering nature and therefore this report deals mostly with those topics, but I will try to give an indication of what performance users can expect as well.

Starting with the building, which has of course been complete for some time, the main thing of note is that proper electrical and mechanical workshops have now been installed in the basement. There have also been improvements to the various control systems for the doors, roof shutters, and drives to try to make them "astronomer proof" (the need for these having been demonstrated by having the project scientist carry out the closing up sequence at a very late hour on a very cold night and having to disentangle the results with some very large hammers.) The smooth movement of the building continues to impress visitors, although we hope to do more to reduce the slight lurches at the beginning and end of a slew which can, when taken together with the usual effects of 14,000 ft, induce some rather green faces among people trying to focus on VDU's or whisker pins. (Unlike that of a conventional dome, the observing floor of the JCMT carousel also rotates - Ed.)

The membrane is now fully operational and has just completed its wind tests. These had been scheduled for late February in the hope that there would be some wind, but I for one was not very optimistic because it had been a relatively calm winter and the general experience is that the wind down at JCMT is very light even when it is blowing hard on the summit ridge. As it turned out we had rather more wind than we needed with speeds of over 160 mph recorded at CFH and at one point we had to evacuate the site because substantial rocks were joining in with the airflow. In fact the highest gust recorded at JCMT was 90 mph, demonstrating again the advantage of our site (see Fig. 2). The membrane did extremely well. In fact we were almost disappointed to find that the computerised system for sensing the movements of the membrane was barely flickering when the wind speed reached the design maximum of 50 mph. Further work will be needed to determine what is a safe limit for operation but it seems likely that the strength of the membrane material will not be the limiting factor. We have also found that it is possible to operate the telescope without the membrane in winds of up to 20 mph or so before pointing errors and the loads on the structure become excessive. This is again well above the specification, but of course such winds are fairly common so that it will be necessary to use the membrane most of the time. It is however still true that we will need to limit the number of times the membrane is taken up and down (because of the wear and tear as well as the fact that it does need expert attention at this stage at least). We have of course not yet established that there are any observations for which it will be necessary to remove the membrane, apart from the optical pointing tests. The indications are that the signal losses are at about the level expected - that is a few per cent: measuring this accurately is a high priority for the RF testing which is now starting.

The telescope drives are generally working well. The elevation bearings have been reset and as had been hoped this appears to have eliminated the hysteresis which had been present. One of the precision encoders failed and this caused some delay, but it has now been repaired. The positioning properties of the servo are now extremely good with "limit cycling" on a fixed position of no more than half an arc second. Preliminary results from tracking the limb of the moon using the 230 GHz receiver indicate that the short term tracking is also good. Values of about 0.3 arc seconds rms in each coordinate were measured, although this did appear to deteriorate somewhat in the parts of the sky where the telescope was moving very slowly. Some more pointing measurements have been made, both using the optical sighting telescope and at 230 GHz using planets. In general very good fits can be obtained to these measurements - residuals of 2 or 3 arc seconds rms in each axis in the best cases - using a simple model to represent the telescope. However we have not yet achieved pointing as good as this from night to night and there is much to be done to sort out the relationship of the radio and optical pointing, to account for the movements of the secondary mirror and to understand refraction. On this latter point we have seen large rapidly changing shifts in the apparent positions of sources when observing in the afternoons with the typical Mauna Kea afternoon cloud passing overhead.

The less successful part of the telescope program has been the setting of the surface. There have been many problems and delays with the measuring machine but it was eventually possible to get the surface set to about 90 microns accuracy in November 1986. A further set of measurements are underway at the time of writing. We have also used the "holographic" method to obtain maps of the errors in the surface. So far this has been done at 31 GHz. It was clear that a higher frequency would be needed to get the accuracy called for on JCMT and so the equipment needed for measurements at 90 GHz has been prepared and tests are planned for late March. We still hope to achieve the specified figure of 50 microns in time for the first scheduled observations but obviously the slow progress in this area is worrying.

Much also remains to be done on the software. The emphasis has been on getting the details right for things like the tracking of planets which are essential for testing the telescope and so it has not yet been possible to get the whole system into a very user-friendly state. No doubt the arrival of fresh users will bring to the surface plenty of new bugs!

Very little actual observing has been possible so far because of the need to deal with all the technical problems - inevitably observing comes at the end of the line because everything has to be working first! On one short evening when it was all going we did manage to get a nice spectrum of Orion and a rather noisy first extragalactic signal from M82 (Fig. 3). Obviously the productivity of the telescope should start to increase rather rapidly from now on but I feel that the observers coming out during the early period should not set their expectations too high.

Richard Hills

APPLICATIONS FOR TELESCOPE TIME: RESULTS FOR SEMESTER L

1. Statistics

The Panel for the Allocation of Telescope Time (PATT) received over 80 proposals requesting time on the JCMT; total time requested amounted to 470 nights. The Principal Investigators (PI's) came from 24 different institutes (13 were UK plus Hilo, 4 were Dutch, 7 elsewhere). Taking PI's and CoI's 45 institutes were involved.

Of the 80+ proposals, 11 had PI's from the Netherlands, 11 had PI's from Japan, 5 had PI's from the USA (excluding Hilo); the rest had UK (including Hilo) PI's (13 of these were Edinburgh or Hilo, 15 were QMC, 15 MRAO and 13 were from the rest of the UK).

27 proposals requested Receiver A, 37 requested Receiver B and 25 requested UKT14 (several requested more than one receiver).

2. Outcome

The time available for observations in Semester L has been considerably reduced as it is now expected that the telescope will not be handed over until 1 July. From 1 July till the end of the semester 50% of the nights (from 6 pm till 6 am) will be available for scheduled observations. This semester is therefore heavily (~15 times) oversubscribed. In addition the telescope pointing, beam profiles, efficiency, etc are not yet well ascertained so in assessing proposals the panel favoured those which proposed observation of bright sources.

Accordingly, the following proposals were allocated time:-

Watt (HTU) and Wootten (NRAO)	Confirmation of interstellar H_30^+
White (QMC)	Submillimetre wavelength observations near ionisation fronts
Sato (Kyoto)	One millimetre continuum observations of protostellar objects
Kaifu (NRO)	Dynamics and excitation of the molecular ring at the Galactic centre
Hasegawa (NRO)	Structure of warmed molecular gas around reflection nebulae
Griffin (QMC)	High resolution 800 micron mapping of IRAS sources in dark clouds
Israel (Leiden) and Smith (HTU)	Giant molecular clouds in M31 and M33
Clegg (UCL)	Submillimetre observations of planetary nebulae
Padman (MRAO)	The rotation curve of the S106 molecular disc
Hills (MRAO)	Cepheus A; one outflow or two?
Padman (MRAO)	HCO^+ observations of M17SW
Scott (MRAO)	The highly energetic outflow in DR21
Webster (HTU)	Search for interstellar MgH
Jaffe (Leiden)	Molecular gas in the cooling flow galaxy NGC 1275
Lasenby (MRAO)	High resolution SO_2 observations of the hot core of Sgr B2

Scheduling of these projects will be completed in April and the PI's will then be notified of their observing slot. They will also receive information regarding visits to the JCMT. In particular, their attention will be drawn to the need for medical examinations for visitors to confirm their fitness for work at 14,000 ft.

3. **Comment by Adrian Webster**

The JCMT is already obtaining exciting spectra of interesting objects, so all in Hawaii are optimistic that good astronomy will be done in Semester L. It is still a struggle, however, and those users who will come to Hawaii in that semester are asked please not to expect the standards of efficiency that will only come with experience.

Jocelyn Burnell

APPLICATIONS FOR TELESCOPE TIME: ARRANGEMENTS FOR SEMESTER M

1. **Closing Date**

PATT deadlines have been advanced by one week. For Semester M (September 1987–February 1988) the closing date for applications will be April 30, 1987. Otherwise, arrangements are as stated in the previous issue of PROTOSTAR. For the benefit of new readers the following section is repeated:

The postal address to which applications should be sent is the following:-

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

Enquiries may be made by telephone (0793–26222) or Telex (449466). 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.

2. **Service Observing**

The Service Observing concept has been discussed by Longair, Stewart and Williams (1986); it is, for example, a means by which an astronomer can obtain pilot observations before making a full PATT application and without having to visit the telescope. It is hoped to institute Service Observing on the JCMT for a small percentage of Semester M. More information will be made available on REVAD::DISK$USER1:[JCMT].

Reference:

Longair, M.S., Stewart, J.M. and Williams, P.M., 1986. Q.Jl.R.Astr.Soc., 27, 153.

EQUIPMENT AVAILABLE ON JCMT DURING SEMESTER M

1. **Heterodyne Systems**

(i) Front End A

This is presently operating at 230 GHz with receiver noise temperatures of less than 600K SSB in one channel and less than 900K in the other. In general the performance is well up to expectations and the total power stability is particularly good. Our first attempt at an extragalactic detection (the CO J = 2–1 line in M82) was successful with an integration time of 4 mins. It is still expected that the upgrade of this receiver to cover the bands from about 218 to 235 GHz and 256 to 270 GHz will be completed during the summer. The mixers and the local oscillator components have not yet been delivered however, so there is still some uncertainty about timescales and the exact tuning range that will be available. There will probably be several steps in the upgrade – first to extend the 230 GHz band, then to introduce the 260 GHz components, and finally to replace the commercial phase-lock system with an MRAO one to provide a "clean" local oscillator. It is now planned to install and test the new components in Hawaii, so that the receiver will only be out of commission for periods of a few weeks for the upgrades. More details of the upgraded performance should be available on REVS::JCMT shortly before the PATT deadline. Users with special requirements are urged to contact R Padman at MRAO.

(ii) Front End "B"

Test spectra of the CO J = 3–2 line have been obtained with this receiver, but it has not yet been fully characterised over its full tuning range, which is specified as 320 to 370 GHz. There are some problems with this system which affect pointing and calibration measurements at present and some difficulties with the bias circuits need to be resolved. It is nevertheless reasonable to assume that this system will be available for essentially all of the semester, with performance close to the original expectation of 800K SSB at 345 GHz and 1000K near the band edges.

(iii) Front End "C"

This is a new system being built by MRAO and QMC to cover the 461 GHz CO and 492 GHz Carbon lines. Construction is well advanced but again the key components have not yet been delivered so timescales and performance are uncertain. It should, however, be available for most of the semester and it is expected that the noise temperature will be around 500K. This is a double sideband figure, but because the detector is an InSb bolometer with no more than 1 MHz of IF bandwidth the equivalent SSB figure for a conventional mixer is obtained by multiplying this number by the square root of the number of channels in the spectra to be observed. Applicants should also note that the atmosphere even on Mauna Kea is often not useable in these windows and therefore a backup programme is essential.

2. Bolometric System UKT14

This has been used successfully on JCMT with the two-axis chopping secondary. Good signal strength and beam shape were seen at both 1100 and 800 micrometres wavelength. There were no obvious problems of microphonics or resonances with the chopper and the "throw" achieved is better than specified. (For 80% duty cycle one can use 1 arc minute on the sky at 10 Hz and 4 arc minutes at 5 Hz.) As expected the noise seemed to be dominated by the detector (at the longer wavelength at least) and therefore the sensitivity should be close to the predicted value of 0.3 Jy (1 sigma 1 second). It has unfortunately not been possible to test this directly nor to check the coupling of the detector to the telescope, but again it is expected that a lot more information will be available by late April. The polarimeter will be tested in May and provided it works well it should also be available whenever UKT14 is on the telescope.

A great deal of work on software is still needed to make the bolometer, the secondary mirror and the telescope work together efficiently and to provide for sophistocated reduction of data, and users should consult B Duncan in Hawaii if they have special requirements.

It is expected that, during Semester M, UKT14 will be available at JCMT for perhaps 3 periods of a few weeks each and on UKIRT for a similar amount of time but this will, of course, depend on the demand from users and other scheduling constraints.

3. Backends

(i) Digital Auto-correlator

This has not yet been put into operation, mainly because of delays on the software side, but is expected to be available for Semester M. The 512 channels can be divided up in different ways so that with the dual polarisation front end it gives 2 sets of 256 channels covering 40, 80 or 160 MHz, or with a single input all 512 channels can be used together to give twice as much resolution on the same bandwidths and also to cover 320 MHz. Users should note that the 1-bit digitisation imposes the penalty of an increase in the noise by a factor of about 1.5, but the correlator may have advantages in stability for long integrations and certain types of mapping.

(ii) Acousto-optical Spectrometer

This has been used successfully for test observations with both A and B front-ends. The baselines appear to be quite satisfactory (although no long integrations have been made as yet) but there is a substantial increase in the noise level at the two ends of the spectra and it remains to be seen whether or not this can be removed. Arrangements have been made to multiplex the two outputs from receiver A into the single 500 MHz-wide band of the AOS so that two independent versions of each spectrum can be obtained in cases where a bandwidth of not more than 200 MHz is needed. Again there is much to be done on the software side to integrate this instrument (which was originally built as a stand-alone device) with the rest of the system.

Richard Hills

THE JCMT USERS' COMMITTEE

The JCMT Users' Committee was set up to give advice to the SERC on the scientific development and exploitation of the telescope. It is the principal channel of communication between the telescope users and the project, and potential users may find it of value to know who the present members of the Committee are:

Professor R D Davies (Chairman), Manchester
Dr P A R Ade, Queen Mary College
Dr J M Brown, Oxford
Professor W B Burton, Leiden
Dr A M Flett, Aberdeen
Dr J H Hough, Hatfield
Dr R D Joseph, Imperial College
Dr G H Macdonald, Kent
Dr P F Scott, Cambridge
Dr H van de Stadt, Utrecht
Dr G White, Queen Mary College
Professor D A Williams, UMIST
Dr G Wynn-Williams, Hawaii

DIARY

April 27, 1987:	Formal opening of the JCMT by HRH The Prince Philip, Duke of Edinburgh.
April 30, 1987:	Last date for applications to PATT for Semester M (September 1987–February 1988).

June 21–27, 1987:	Millimetre and Submillimetre Astronomy Summer School at the University of Stirling, Scotland.
July 1, 1987:	The JCMT becomes the responsibility of the Royal Observatory, Edinburgh and observing programmes start.

STARLINK Directory for JCMT News

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JCMT Section
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Royal Observatory
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Edinburgh EH9 3HJ

Editor: Alex McLachlan

STARLINK Address: REVAD::AML
JANET Address: AML@UK.AC.ROE.STAR

Telephone: 031-667-3321

Telex: 72383 ROEDING

Secretary to –
Hawaii Telescopes Unit: Mrs Maureen McLean, Ext 214.

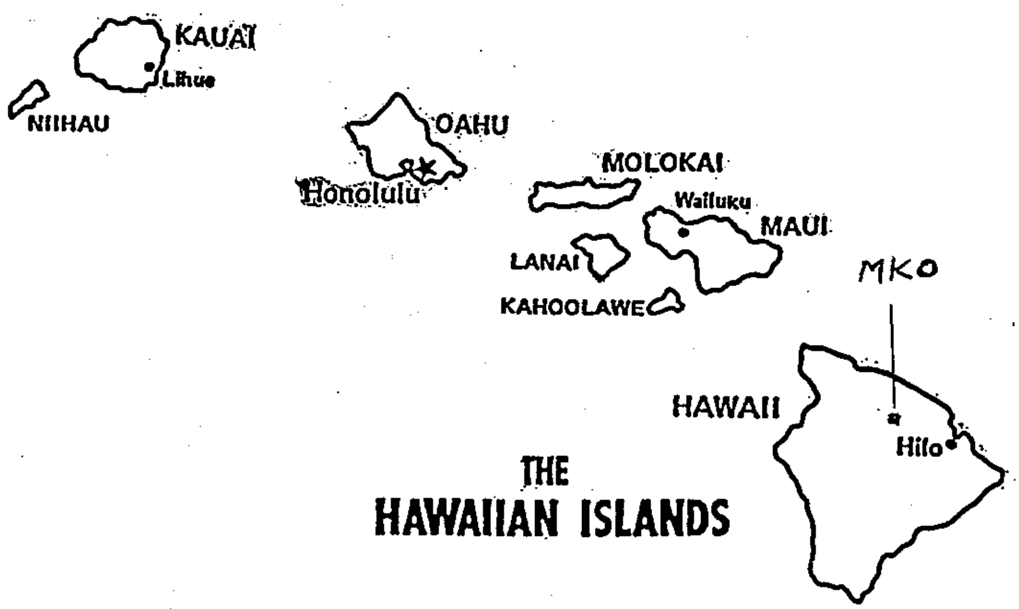


FIG. 1 *Mauna Kea Observatory is located on the island of Hawaii – the "Big Island" in the Hawaiian chain of islands.*

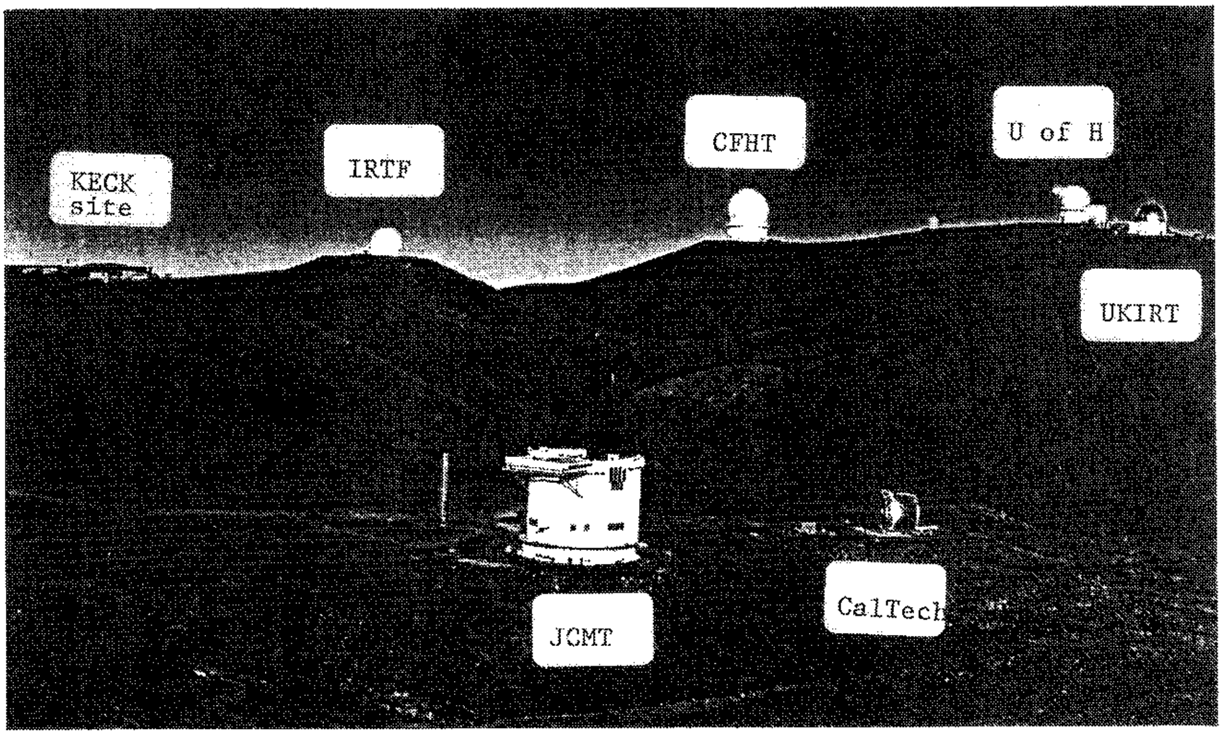
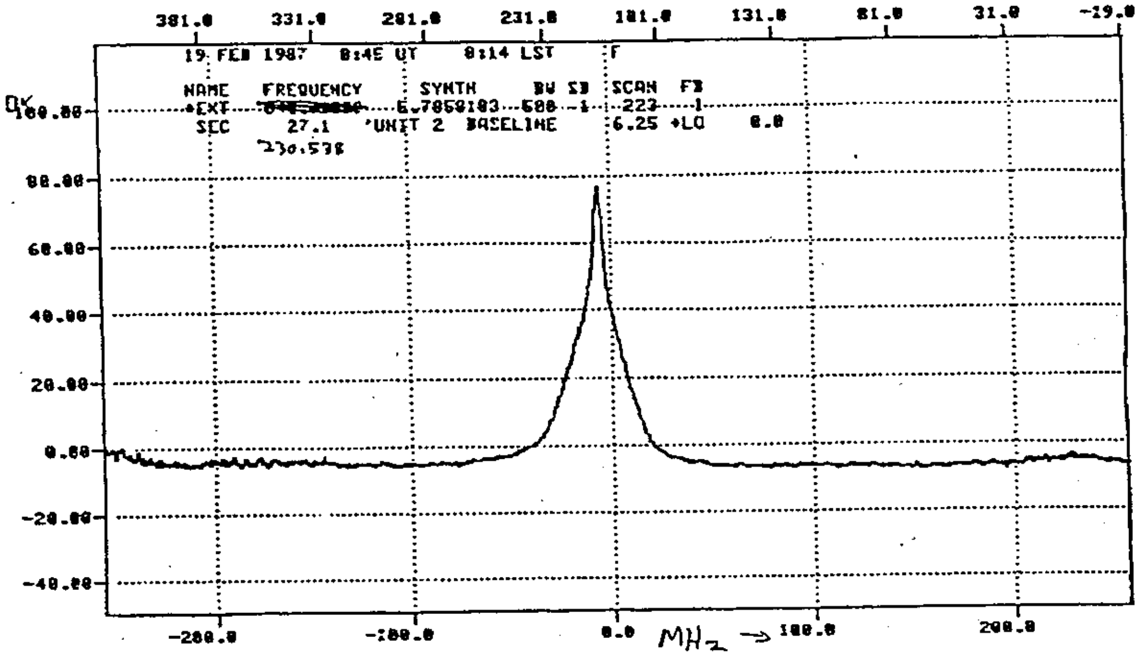


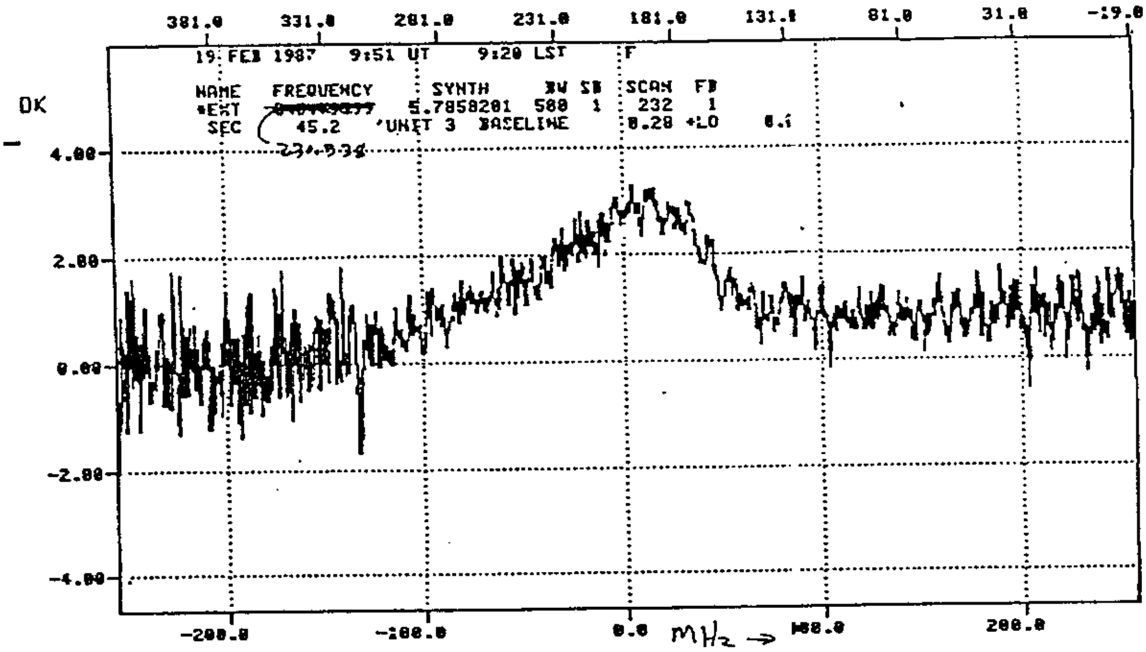
FIG. 2 *This high contrast reproduction of a photograph of the Mauna Kea summit area shows the relative positions of the major telescopes. The radio telescopes are located in "Millimetre Valley" about 100 metres below the main ridge.*

Orion A



1½ minutes integration on source.

M 82



4 minutes integration on source.

FIG. 3 *Observations with Receiver A of CO (J = 2–1) emission from the Orion A molecular cloud and the M82 galaxy.*