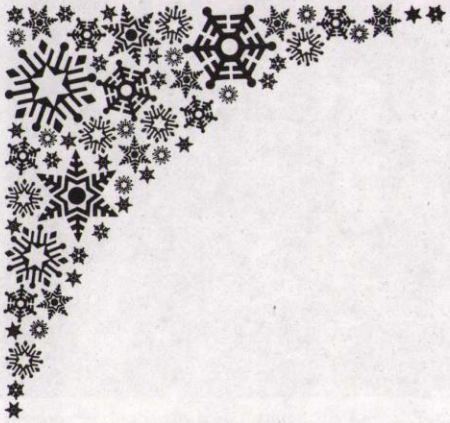
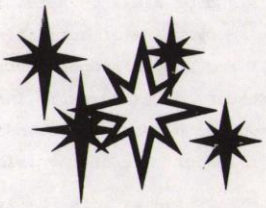
Bulletin

of the Rutherford Appleton Laboratory 20 Dec 1982 No.20

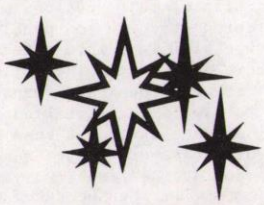


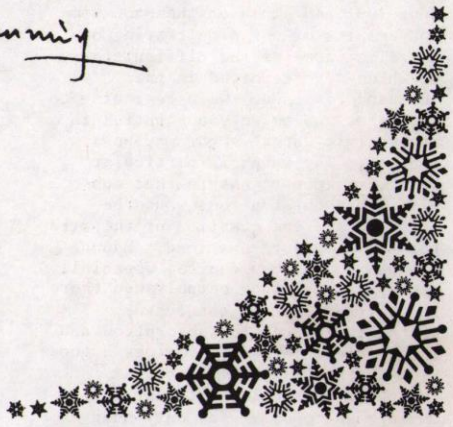


A Christmas Message

is now almost over - it has been a year of solid work and considerable success; first results from the proton-antiproton collider, successful operation of the new krypton fluoride gas laser (SPRITE), the launch of the SERC Common Base computing programme, acceptance of the Along-Track Scanning Radiometer experiment on the European Remote Sensing Satellite 1 to be launched in 1987 and the start of the first experiments on UNIVERSE, are all examples. 1983 will bring new challenges and opportunities, and I am confident that you will all meet them with the same drive and determination that you have shown during 1982. Congratulations to you all and I wish you and your families a Merry Christmas and a Happy New Year.

Geoff Manning





Impact on Hawaii

Two years ago the proposed Millimetre-wave Telescope (MT) was described in the 'Bulletin' (15 December 1980). The project has seen some changes since that time, the most important of which is the move of the observatory site from La Palma in the Canaries to the Island of Hawaii. Here, Jim Hall gives an overview of activities on Hawaii and Tony Eastwood describes an instrument he has recently installed for monitoring observing conditions and his experience of the island.

The Island of Hawaii is the largest of the mid Pacific Hawaiian chain. All the islands are volcanic in origin and Hawaii itself is the youngest. It is formed from five closely-spaced volcanoes, one of which is still active. The highest peak at nearly 14000 feet, is Mauna Kea and at its summit, perched on the old cinder cones, is an astronomical observatory that is rapidly becoming a world-beater. Already there are two minor and four major telescopes and plans are at an advanced stage for the construction of three further major telescopes this decade with another four before the year 2000. This observatory is controlled by the University of Hawaii but it has a truly international character. The largest of the existing instruments is the UK Infra Red Telescope (UKIRT) operated by ROE and the largest of the planned mm-wave telescopes is the UK/NL MT for which RAL has prime responsibility.

The NL in its title recognizes a partnership which now exists with the Netherlands counterpart of SERC, the Organisation for Advancement of Pure Science (ZWO), which is providing 20% of resources for the MT in return for 20% of observing time. The agreement with them was made in June 1981 and at about the same time the results of our site testing on La Palma (some of the difficulties of which were reported in the 16 March '81 issue) were beginning to show that sub-mm wave absorption in atmospheric water vapour may be a problem. The Dutch in particular were very keen to ensure that sub-millimetre observations would be possible and the question of the site for the MT was re-examined. Mauna Kea was an obvious choice, especially as UKIRT is already established there. The altitude of the observatory virtually ensures low absorption and the tropical latitude provides a good view of the Galactic centre, a region of particular interest in mm-wave astronomy. The only snag

Existing telescopes on the summit cinder cones of Mauna Kea. The silver dome to the right is the UK Infra-Red Telescope. The height of the cloud layer is, as usual, about a mile below the summit. Photo:ROE

was the considerable cost of building on such a distant mountain top. Much ingenuity has been shown in reducing the scope of the project, not for the first time, to keep it within the original budget while at the same time extending rather than limiting the scientific objectives. Eventually it was possible to show to everyone's satisfaction that the costs could be contained and the project was given the go-ahead a few months ago.

Planning

Since then, while engaged on a complete redesign of the enclosure and further development of the antenna to produce a more accurate instrument, RAL has begun to create an impact across the other side of the world. Visits have been made to produce draft agreements with the University of Hawaii and to set the State and County planning procedures in motion. Ground borings have been made on the mountain, the beginnings of our meteorological station are evident and a new instrument to monitor atmospheric seeing at millimetre-waves has been designed, constructed and installed by Tony Eastwood (see below "Aloha MSM!")

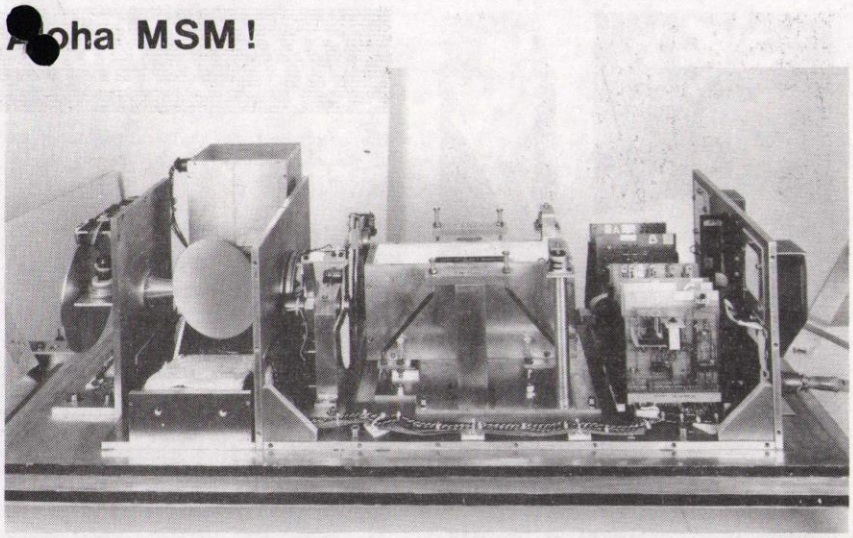
The planning processes are anything but simple. Mauna Kea is a so-called Conservation District and any activity that may affect the environment has to be considered from a multitude of aspects. It is mandatory to produce an Environmental Impact Statement, which in this case is a document running to over 500 pages, and to allow periods for public comment and to hold public meetings, before any State permit can be obtained. Hopefully, the bureaucratic processes will soon have run their course and, with suitable prodding, our permit will appear.

Rick Mason, representing the Council Works Unit, has produced a few impacts of a different sort. The summit of Mauna Kea is composed of cinder cones and volcanic debris overlaying lava flows. To ensure that our chosen site is stable and suitable for construction, a drilling rig was dragged up the mountain and set-up in the late summer of this year. Hampered by an unusual period of rain (no-one will ever persuade Rick that Mauna Kea is a dry site) a group of six holes were driven to a depth of about 50 feet. Fortunately the tests showed the underlying material to be uniform over the site and sufficiently load bearing for our purposes.

The Way Ahead

Early next year it is anticipated that all the agreements will be signed, planning permits will be granted and contracts placed for site clearance to begin in April. Before the snows return next autumn, the concrete work should be completed in preparation for erection of the carousel, the rotating part of the enclosure, during the following summer. Early next year also, the carousel design will be put out to tender for manufacture in 1983 so that it can be shipped out in the Spring of 1984 for erection at the scheduled time. The antenna design will be refined, test sections made and a preproduction run on panel manufacture will lead into antenna manufacture and its trial erection in the UK. It will then be dismantled, shipped to Hawaii and installed in the carousel as soon as it has been completed. State-of-the-art receivers, produced during the final two years of the project, will then be added and the MT will become fully operational in 1986.

Aloha MSM!



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The Millimetre-wave Sky-emission Monitor (MSM), designed and built at RAL in collaboration with the Cavendish Laboratory, Cambridge, has recently been installed and successfully commissioned on the 14000 ft peak of Mauna Kea, Hawaii. The MSM, is now sitting on the roof of an annexe to the UK Infra-Red Telescope. UKIRT is currently being operated by a team from ROE. supplemented by locally recruited Hawaiian staff and a key factor in the rapid and trouble-free installation was their very helpful cooperation.

The MSM is now gathering information on the mm-wave transmission properties of the atmosphere close to the proposed site of the Millimetre-wave Telescope currently under design at RAL. Such information will be important in planning the scheduling of the MT and perhaps of UKIRT too. Atmospheric water vapour is the primary cause of absorption and, as this is a variable quantity, it is essential to have good statistical data. Until now, these statistics have been obtained by using infra-red 'water-vapour meters' but they are manually operated instruments and measure mm-wave absorption indirectly. The MSM was therefore designed for continuous automatic operation using a car battery for power and recording data on tape. The instrument operates at the wavelengths of interest and actually measures the emission temperature of the atmosphere, a parameter directly related to absorption.

The atmospheric emission is detected by a Golay cell, which is the most sensitive form of uncooled bolometric detector available for milimetre-wave and far-IR signals. Unfortunately a Golay cell is also very sensitive to microphonics and the whole instrument had to be mounted in a heavy box suspended on springs. The cell responds best to changes in the incoming signal, so a chopper wheel is used to modulate the signal and a phase-sensitive detector to demodulate it. The output is then the difference in temperature between the chopper wheel and the input beam from the sky but the signals are weak and have to be smoothed with a long time-constant of 7 seconds. Three millimetre wavebands are selected by mesh filters in front of the Golay cell in order to cover the spectral region of interest to the MT. A polythene lens is used to focus the radiation and a scanning mirror allows the instrument to see a 5^{o} patch of the sky at several elevation angles followed by hot and ambient temperature reference sources. A microprocessor steps the scan mirror and filter wheel in a predetermined sequence and also monitors their status. The output signals together with temperature and status words are recorded on the data logger.

The outer box (not shown in the photograph) and the baseplate provide thermal insulation and weather protection using a mechanically strong but lightweight composite sheet manufactured at RAL. This consists of a rigid PVC foam faced by aluminium alloy sheets and with threaded nylon bushings for ease of assembly. The window in the cover, which allows the atmospheric emissions to enter the MSM is covered by a special type of PTFE woven cloth which is transparent to the wavelengths of interest but keeps out rain and dust. Prior to dispatch, the MSM was thoroughly tested in the climatic chamber at the Cavendish Laboratory where the temperature was cycled between $+30^{o}C$ and $-13^{o}C$ to simulate the extremes of Mauna Kea.

A Tropical Paradise?

The trip to Hawaii was quite outside any previous experience - the 17 hour flight and the 11 hour time difference; the arrival at Hilo where the day-time temperature is consistently in the mid-eighties and the humidity hits you like a wall; the profusion and variety of tropical flowers and lush green vegetation; the curious but not unpleasant, all pervasive smell in the air; bananas, coconut palms, papayas, to name but a few, growing in suburban gardens; tens of thousands of acres of sugar cane; evening flockings of Mynah birds; the occasional mongoose scurrying from one dark corner to another; inch long cockroaches and strange sounding Hawaiian names and accents.

The summit of Mauna Kea can be clearly seen from Hilo and from most of the east coast of the island. The mountain slopes evenly (by Alpine standards) down to the sea, apparently because the lava flows have low viscosity. Upon closer inspection, the summit looks like some overgrown slag heap dotted with cinder cones in varying stages of delapidation and it does give one the impression that it really can't be almost 14000ft high. This thought is rapidly dispelled as one drives from Hilo to the mid-level Hostel at 9000ft. The steady climb, in a specially tuned four wheel drive pick-up truck, takes about an hour, passing through ancient lava fields and stunted vegetation and the air temperature steadily reduces to about the mid-fifties. The walk up the steep slope from the Hostel car park to the canteen makes one fully aware of the effects of altitude and an overnight acclimatisation period is usually recommended before going on up to the summit to spend the day. Since we were going to the top for just a short visit, we spent only the time needed to drink a cup of coffee before setting off to the summit.

The last 9 miles of the journey is by way of a loose gravel track. After about 4 miles the curious local vegetation (aptly called Triffids by the British thus causing much mystification to the Hawaiians) completely disappears and the scene all around, varying in shade from slate grey to a rich reddish brown, is remarkably like the surface of the moon as seen during the Apollo ventures. After negotiating many hairpin bends and a final steep section one arrives at the summit some 25 minutes after leaving the hostel, feeling very slightly breathless from the exciting drive, the lack of oxygen and the stunning view.

The air temperature when I was there was never much above freezing point, despite the tropical latitude and the intense sunshine. The atmosphere was extremely dry and so the application of lip salve and the frequent intake of liquids (definitely non-alcoholic!) are essential. The atmospheric pressure is less than two thirds that at sea-level and a close watch is kept on the well being of all new arrivals at the summit. (Tea drinkers should note that since water boils at a considerably lower temperature at this altitude, a good 'cuppa' is not possible!)

The several days spent at altitude and subsequent return to the steam heat of Hilo, the earlier visits to the active volcano region with its sulphur rocks, steam vents and still-hot lava beds and to the cactus strewn desert regions in the north-west all served to illustrate some of the truly remarkable contrasts to be found on the 'Big Island'. A tropical paradise? - perhaps not quite, but if we could just move RAL about 10000 miles to the left and down a bit .....

Tony Eastwood

Saved by the Bell

The more formal part of the proceedings on the occasion of Marshall King's retirement were brought to a sudden end by the sounding of the Fire Alarm bells in R4. David Gray had outlined Marshall's long career at Harwell and RAL. Marshall came to Harwell in 1953 having convinced his interview board that, even if he did not know the answers to their technical questions, he did know where to look up the answers. He has always kept that philosophy with his excellent library of reports on accelerator topics.

While still at Harwell he worked on charged particle dynamics in linear accelerators. In particular, he developed the notion of the phase space representation of particle behaviour. He derived the notions of 'acceptance' and 'emittance' which are now everyday concepts in the accelerator and beam world. He then went on to work on spiral ridge cyclotrons and in 1958-59 went to the University of Florida as a visiting professor.

Following that he moved to beam design and analysed the techniques which could be used for separated beams using electrostatic separators. These were to become a common sight around all accelerators including Nimrod.

Marshall went to CERN in 1962-63 to work on the PS improvement programme and returned to Chilton to be in charge of the Beam Physics Group which dealt with the design of the layout and beams for the Nimrod experimental programme. He was responsible for development and commissioning of the extraction system for Nimrod. During accelerator-off times he showed his ability at writing limericks - some of which might be printable!

Marshall was promoted to Merit SPSO in 1971. He spent another period at CERN in charge of the SPS Theory Group. During this time he was well known for imparting culture - as a

darts player at the Wellington Pub. Sometimes his practice of ballistics and aerodynamics was not as good as his knowledge of accelerators! He was involved in the design study for EPIC and then turned his attention to the use of accelerators for energy production. He pressed for the SERC programme in Heavy Ion Fusion which led to the UK having an accepted expertise in this novel form of energy production for the 21st century.

David presented to Marshall a gift from his colleagues which his wife had indicated he would find useful - a powerful Black and Decker planer.

Marshall began his reply by indicating that with the change in the Laboratory programme he had applied for VPR in order to give some younger people a chance. He had some advice. There were two things that a good theoretical physicist needed. One was a good memory, the other . . . . he couldn't remember. Further advice was interrupted by the aforementioned bell. All then retired to the 'local' in Harwell village. The photographer was able to snatch the photograph with appropriate background and with Marshall and David discussing what some people thought was a copper model of a superconducting RF separator cavity.

'Poppy' Collection

The Royal British Legion 'Poppy Appeal' this year raised £162.72 - which was £52.46 more than last year. Many thanks for your generous donations and a special thank you to the Messengers for undertaking the task of collecting.

'100' Club

The November draw took place in R58 on Wednesday 1 December. The winning number for the £25 prize was 68 and belonged to Mr Alan Hipwell.

Acknowledgement

Mrs Ann Walter would like to thank all the people who sent her letters and cards of sympathy. She writes, 'Many of them are my friends as well as Anton's friends and colleagues, and I am sincerely grateful for the many offers of help I have received.'

Film Badge Notice

Period 1 Colour strip ORANGE commences January 1 .
Please ensure all old films are returned to enable the records for 1982 to be completed.

RAL Lectures

The next lecture in this series will be held on Thursday 13 January at 3.15pm in the Lecture Theatre.

CHAOS and ORDER in
NEWTONIAN MECHANICS

by

Professor M V Berry, FRS
H H Wills Laboratory,
University of Bristol

A pendulum is 'as regular as clockwork' and a pinball machine is the epitome of unpredictability, yet both systems are accurately described by Newtonian mechanics. Recent understanding of how both sorts of motion are contained in the same equations will be illustrated by the 'billiard' motion of a particle bouncing in enclosures of different shapes.

Safety Film

The next Safety Film is scheduled for Wednesday 19 January 1983 at 12.00, 12.40 and 13.20 hrs and is entitled 'You Can Save Lives'. The film will be shown in the Lecture Theatre.

It is another new film which is of direct interest to all who drive and all who need to know about emergency first aid - everyone in the Lab. should see it.

With My Thanks

Just once a year your Editor feels justified in using space in the *Bulletin* to say a word on her own behalf - Thanks! To everyone who has helped with the production of this publication during the past year, I offer my sincere gratitude. The support I have been given by all my colleagues in the typing pool, reprographics and photographic sections has been invaluable. Contributors have slotted my requests for copy into their already hectic lives with much good grace and kindness - and come up with the goods. Readers have been generous with advice and suggestions (some of which could actually be implemented). Please keep the ideas coming in - they are appreciated, I promise. Thank you once more. May you all enjoy a Happy Christmas and a Bright New Year.

Bulletin

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