



La Palma

GEMINI



Herstmonceux

Newsletter of the Royal Greenwich Observatory

No. 16

April 1987

The Relocation of the Observatory

At its meeting on 18 June 1986 the Science and Engineering Research Council decided that the Royal Greenwich Observatory should move from its present site at Herstmonceux Castle in Sussex to Cambridge on a site adjacent to the University of Cambridge's Institute of Astronomy.

The Royal Greenwich Observatory was founded by Charles II in 1675 and for the first 273 years of its existence was based at Greenwich in SE London. In 1948 it was moved to its present site in order to take advantage of the clearer skies available in this part of Sussex. In recent years the role of the Observatory has changed dramatically. Although a number of telescopes remain on the site and are used for astrometry and instrument testing, the 2.5 metre Isaac Newton Telescope was refurbished and moved to the new Roque de los Muchachos Observatory on La Palma in 1983 where some of the best observing conditions in the world are to be found. Indeed all of the major ground based observing facilities supported by the UK are now located on overseas sites. The reasons which attracted the RGO to Sussex in 1948 therefore no longer apply.

It has become Council policy, as stated in its Corporate Plan (December 1985), to operate its Establishments in support of University and Polytechnic Science and Engineering, rather than as independent research institutes. In view of this, and the removal of major research telescopes to overseas sites, the Council has decided that its support for astronomy will be best provided by a closer association of the RGO with university astronomers, scientists and engineers and that this will be facilitated by a relocation of the Observatory to Cambridge University.

It is the SERC's intention, where practicable and where it is in the best interests of the science, to move all the RGO's associated activities to the Cambridge site, with the aim of maintaining its integrity and identity in the new environment. Clearly the Equatorial Group of Telescopes cannot be relocated and discussions have begun with the National Maritime Museum regarding their operation in order to preserve the public interest and educational aspects in Sussex but also to provide the Council with access to the facilities for instrument testing.

Discussions are as yet at an early stage, but it is likely that some aspects of the RGO's programme may be relocated to Cambridge during 1987/88 (e.g. HIPPARCOS) in order to preserve programme integrity. The main move is however not expected until 1989/90.



David Calvert

Two main bodies have recently been established centrally to oversee the move; a Steering Committee, under the Secretary, SERC, Dr Catterall, whose terms of reference are to inform Council of the progress on the implementation of the

decision to move the RGO and to draw to its attention any difficulties it perceives. The membership of the committee is:

Dr J A Catterall	(Chairman)
Professor M J Rees	(Cambridge)
Dr K J Edwards	(Cambridge)
Professor A Boksenberg	(RGO)
Professor R S Ellis	(Durham)
Professor R D Davies	(Manchester)
Professor A H Cook	(Cambridge)
Professor Sir F G Smith	(Astronomer Royal)
Professor H van der Laan	(Leiden)
Dr B R Martin	(Secretary)

This committee will report to Council.

The other main body is the Relocation Project Group which reports directly to the Chairman of Council, Professor Mitchell. Its terms of reference are to determine policy to be followed in implementing Council's decision. It will be particularly involved in dealings with the Treasury, the sale of the Castle, programme protection and phasing issues.

The membership of this committee is:

Mr G L Addison	(Chairman)
Professor A Boksenberg	(Director, RGO)
Dr J A Catterall	(Secretary, SERC)
Mr M C Morris	(RGO)
Mr R Tolcher	(Council Works Unit)
Mr P S Maxwell	(Establishment Officer)
Professor M J Rees	(Cambridge)
Dr B R Martin	(Head APS Division)
Dr W E A Davies	(Secretary, RGO)
Dr A Game	(Secretary)

In addition there are two RGO based committees both chaired by the Director, RGO. Firstly the RGO Relocation Co-ordination Committee has been set up in order to synthesise the overall RGO management input into the Central Relocation Project Group and to manage, at an operational level, the implementation of the move. Secondly the so called Tripartite Relocation Committee (the three parts being SERC/RGO management, TU Side (Non-Industrial) and TU Side (Industrial)) provides for a full dialogue between management and staff on matters concerning the relocation of the work and staff of the RGO from Herstmonceux to Cambridge (and other sites as appropriate) so that the views of the staff are known to management before decisions are taken.

The group will have no executive decision making power but will report both to the Relocation Project Group and the RGO Relocation Co-ordination Committee.

The Equatorial Group

There is continuing discussion with the National Maritime Museum (NMM) about the future exploitation and use of the EQ Group both from the point of view of scientific use of the telescopes and of continuing the visitor centre. In addition, and in parallel to this, East Sussex County Council and Wealden District Council, together with the South East and English Tourist Boards, are to carry out a feasibility study in order to ascertain the potential for development and commercial viability of the Herstmonceux site in order to take advantage of its economic, environmental and heritage aspects in relation to the proposed sale. SERC is cooperating in these discussions.

W E A Davies

CARLSBERG AUTOMATIC MERIDIAN CIRCLE - past the 100,000 mark

In 1986 the Carlsberg Automatic Meridian Circle (CAMC) exceeded its target of 100,000 observations in a full year. In fact, it made about 140,000 observations of stars and planets. These observations will be compiled into a catalogue of 20,000 positions, magnitudes and proper motions of stars, and 2,000 positions and magnitudes of major and minor planets.

The observations made in 1984 and 1985 have already been published in Carlsberg Meridian Catalogues Nos. 1 and 2. About 470 copies (printed by photo-composition from magnetic tape) were mailed to observatories. The meteorological data, which includes records of atmospheric extinction and seeing, have been published in limited editions at 6-monthly intervals.



This multi-exposure photograph of the CAMC taken by David Calvert shows the telescope in action

The CAMC results have already made an impact on several areas of astronomical research. A few of the important results are discussed here.

Fundamental star reference frame (FK4).

About 45000 observations have been made of 1300 stars in the Fourth Fundamental Catalogue, FK4. The positions and proper motions in the FK4 define the positional and kinematic frame to which all stars are ultimately referred. The systematic errors inherent in the FK4 are in the process of being removed by a group working on the FK5 at the Astronomisches Rechen-Institut, Heidelberg. The observations made by the CAMC have been used in the formation of the FK5.

Linking FK4 to the extragalactic frame. The systematic defects of the FK4 can also be removed by comparing it with the VLBI extragalactic frame. The extragalactic frame has *ab initio* no detectable rotation and has been established with milli-arcsecond accuracy. The problem in relating the two frames lies in bridging the magnitude gap between the bright stars of the FK4 (limiting magnitude ~ 7) and the

faint optical quasars of the extragalactic frame. This is being overcome by the CAMC which observes the positions on the FK4 system of 12th-13th magnitude stars around the quasars. The positions of about 2000 such stars have been measured so far.

Another way of establishing the link between the FK4 and extragalactic reference frames is to observe nearby radio stars whose radio positions have been measured with the Very Large Array relative to the extragalactic frame to an accuracy of $\sim 0''.03$. The radio positions of about 30 stars have been published so far. These have been given high priority on the CAMC programme.

Extension of the FK4 reference frame. The FK4 provides a coverage of 1 star per $5^\circ \times 5^\circ$ with a limiting magnitude ~ 7 . This has been extended through the International Reference Stars (IRS) to 1 star per $1^\circ \times 1^\circ$ with a limiting magnitude ~ 9 . The IRS constitutes the most reliable extension of the FK4. The latitude of the CAMC permits it to observe a wide declination range of the IRS ($+90^\circ$ to -45°). Over 15000 of the 40000 stars in the IRS have been observed with the CAMC and the positions sent to the US Naval Observatory which is the international centre for collating observations of the IRS.

HIPPARCOS. The *HIPPARCOS* satellite requires input positions to an accuracy ~ 1 arcsec. However, many thousands of stars in the programme have standard errors of order one arcmin. A concerted effort within Europe is being made to improve these positions. The CAMC has completed about 2000 of the 3000 stars allocated to it. These stars together with the other stars in Catalogues No. 1 and 2 have been sent to the *HIPPARCOS* Input Catalogue team at Meudon. Besides these star positions, 2750 observations of 59 minor planets have been sent to the Bureau des Longitudes, Paris, for updating the orbits of minor planets in preparation for their observation by *HIPPARCOS*.

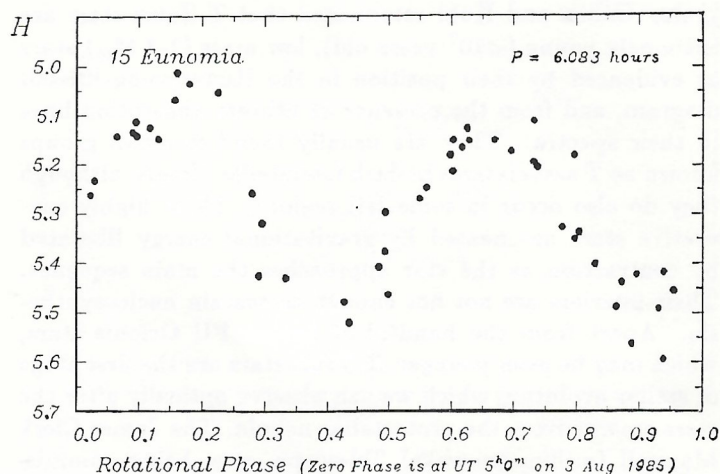
GIOTTO flyby of Comet Halley. The encounter distance of the ESA spacecraft *GIOTTO* with comet Halley in March 1986 was very critical. The success of the mission depended on the predicted path of the comet. One of the determinations of its position before encounter was derived from photographic plates using reference stars with reliable positions. Under contract to ESA, CAMC observed the positions of 350 reference stars in the declination range 0° to -20° which were used successfully to update the comet's position.

VOYAGER II encounter with Uranus (Jan 1986).

The observations of solar system objects have been sent to JPL and the international Minor Planet Center. The 54 observations of Uranus made in 1984 proved to be of considerable importance in resolving discrepancies in the ephemeris of Uranus which were introduced through systematic errors in the reference stars taken from the SAO catalogue. The CAMC positions, which are referred directly to the FK4 system, revealed the systematic errors in the positions determined relative to the SAO. JPL will continue to incorporate the CAMC observations for the *VOYAGER* encounter with Neptune and the *GALILEO* encounter with Jupiter at the end of this decade. JPL describe the CAMC data as 'the latest and seemingly most trustworthy available'.

Physical studies of asteroids. About 2000 photoelectric magnitudes of 51 asteroids obtained with the CAMC in 1984 and 1985 have been analysed at Uppsala and Queen Mary College. Multiple scattering factors and absolute magni-

tudes have been derived. Even though the magnitude errors of the CAMC observations are considerably larger than those of conventional UBV photometry (the CAMC was not designed to do photometry!), this is well compensated by the large interval covered in phase angle and time. These data represent the first determination of the photometric constants G and H for many of the asteroids. For nearly 20 of them not even the absolute magnitude had been published before.



The composite light curve for the asteroid *Eunomia* produced by folding the CAMC observations at an interval of 6.083 hours.

The composite light curves (see, for example, 15 *Eunomia*) agree with previous results and support earlier determinations of the orientation of the rotational axis of the asteroids. The light curves can also be used to generate improvements in the periods.

Work in 1987. Work continues in 1987 on the following projects: faint reference stars in 4 open clusters and around 200 quasars, 17000 International Reference Stars, 150 radio stars and variables. The following groups of stars are being observed in order to improve the accuracy of their proper motions which are to be used in kinematic studies: 2000 G2-G9 dwarf stars, 7000 G/K giant stars, 3000 A5-GO stars in the North Galactic Pole and several thousand stars in OB associations. The solar system objects being observed are Mars, Callisto, Titan, Uranus, Neptune and 63 asteroids.

Leslie Morrison

T Tauri Stars and the Quest for Magnetic Fields

Normal single stars shine because energy which is liberated in their interiors diffuses up to the photosphere where it is emitted by radiative processes. Rather surprisingly, in most T Tauri stars, more than 10% of their bolometric luminosity leaves the photosphere by *mechanical* processes. This enormous mechanical energy flux serves chiefly to drive and heat a massive stellar wind which we see through the broad emission lines that are the defining characteristic of this class of object. Mass loss rates are not well constrained, but typically lie in the region 10^{-7} to 10^{-9} solar masses per year. In some T Tauri stars the evidence for mechanical energy transport is even more startling. Single jets of low excita-

tion gas with velocities of several hundred kilometres per second are seen directed towards us. Close to other T Tauri stars, groups of Herbig-Haro objects are seen with proper motion vectors which project back to and intersect near the T Tauri star. It is inferred that these knots of shocked gas are direct tracers of material ejected by the T Tauri star impinging on dense clouds. The typical velocities of up to a few hundred kilometres per second imply a travel time for material ejected from the T Tauri star of only ~ 1000 years. Cohen and Kuhl established that T Tauri stars are extremely young ($< 10^7$ years old), low mass ($1-3 M_{\odot}$) stars as evidenced by their position in the Hertzsprung-Russell diagram, and from the presence of lithium absorption lines in their spectra. They are usually found in small groups known as *T associations* in dark interstellar clouds, although they do also occur in some HII regions. These highly convective stars are heated by gravitational energy liberated by contraction as the star approaches the main sequence. Their interiors are not hot enough to sustain nucleosynthesis. Apart from the handful of known FU Orionis stars, which may be even younger, T Tauri stars are the first stage of stellar evolution which we can observe optically after the stars emerge from the protostellar nebula. The James Clerk Maxwell (millimetre-wave) Telescope, now being commissioned on Mauna Kea will allow a much deeper probe to be made of the interiors of dark clouds where the much younger protostars must be.

Michael Penston, Teresa Lago and Caterina Sá (now both at University of Opporto) and I have been trying to understand why T Tauri stars have such a large mechanical flux of energy from their photospheres, and what it is that makes them different from evolved sub-giants which occupy the same part of the H-R diagram. Such an understanding may eventually point to the physical processes which lead to a Jeans unstable cloud giving rise to a particular initial mass function, since it is not presently possible to observe directly this part of stellar evolution.

As a first step in this understanding, Teresa Lago set out to determine the physical driving mechanism of the wind. A detailed study of the emission lines in the spectrum of the star RU Lup showed that while simple thermal pressure was insufficient to accelerate the massive wind to the high velocities observed within 0.1 stellar radii of the surface, Alfvén waves, propagating outward along open magnetic field lines could provide the additional momentum input required. In this star a field strength of at least 600 G is required in order to support waves strong enough to drive the wind. Further work by the RGO/Opporto collaboration has shown that several more stars have a similar wind structure to RU Lup, while two others are somewhat different. While the detailed modelling still remains to be done, we infer from the similarities in the winds that similar strengths of magnetic fields are required to drive the winds in many T Tauri stars.

While the Alfvén wave model is certainly consistent with the data and provides a convenient way of heating the wind when the waves are damped, it may not be unique, so I considered it crucial to corroborate the model by trying to observe directly the magnetic fields predicted to be present. We expect at least some of the magnetic field lines to be open in order to admit a wind solution. Such a topology makes the magnetic field *relatively* easy to observe via the Zeeman effect. In our case we expected to be able to measure a relative shift of $\sim 0.15\text{\AA}$ between spectral lines observed first in right-hand circular, and then in left-hand circular

polarized radiation caused by unresolved splitting of spectral lines formed in a magnetic field whose lines of force are viewed "end on". Complex field geometries or an unfortunate aspect can however dilute the power of this diagnostic.

The Pockel's Cell polarimeter, used in conjunction with the RGO Spectrograph and IPCS on the AAT provides a powerful tool for searching for such a differential shift, which, for a 600 G field, corresponds to only ~ 0.1 IPCS channels at $10\text{\AA}/\text{mm}$ dispersion. In February 1984, a run of four nights yielded only one night of useful data due mainly to bad weather.

The spectra obtained were measured using a statistical technique to fit the whole of the spectrum obtained in one sense of polarization to its complementary spectrum. All the spectral lines observed have a similar sensitivity to Zeeman splitting, and a mean value for this quantity was used. The fitting procedure is essentially equivalent to cross-correlation, but allows a formal estimate of the error in measuring the shift. A reliable estimate of this error is vital in determining the reality of the small fractional channel shifts expected. The data yielded a 2.3 sigma result for the star RU Lup at 486 gauss, close to the value predicted from Teresa Lago's model. Three sigma upper limits of 980 G and 1785 G were set for the stars GW Ori and TW Hya respectively. This work is reported in detail in my D.Phil. thesis and in a paper to Monthly Notices.

We also observed the Moon (with the AAT!) as a magnetic null standard in order to obtain an external check on our error analysis. Both internal and external checks on the errors convince us that the error analysis is correct. Formally, there was an 8% chance of obtaining such a significant result for the star RU Lup, in the absence of any magnetic field, when the total number of observations made was taken into account. While this was hardly irrefutable evidence for the presence of the magnetic field, it was nevertheless interesting enough to justify another look.

On the basis of this we were allocated a further two nights on the AAT (of which one was cloudy!) to follow up this work. The new results however do not confirm the presence of a Zeeman shift and a magnetic field. We find this result most frustrating, as, while it *may* indicate that the previous near-detection was merely a statistical fluctuation, it is also possible that we were observing another (less active) face of the star which had rotated between the two sets of observations! The elusive search for the magnetic fields everyone expects to find in pre-main-sequence stars seems to require a newer more sensitive technique than those currently available.

Roderick Johnstone (now at IoA, Cambridge).

THE EXTREMELY LOW METAL CONTENT OF GR 8

The importance of finding regions of interstellar matter of relatively low metal content has been emphasised for diverse problems such as the evolution of galaxies and primordial nucleosynthesis. Also, the difficulty of finding young, unevolved galaxies showing oxygen abundances less than 0.1 of solar led Kunth and Sargent¹ to hypothesize that bursts of star formation contaminate their surroundings with heavy elements, leading to a minimum observable metal content of apparently 0.1 solar.

It remains possible, however, that searches for low abundance galaxies have not been optimized for finding extremely low abundance regions. Typical examples of the search for such regions are those reported by Kunth and Sargent² and Campbell, Terlevich and Melnick (M.N.R.A.S. in press). Their samples of objects were chosen by selecting the highest excitation (generally most metal poor) regions from surveys capable of detecting intense bursts of star formation. Both samples failed to produce candidates with oxygen abundance less than 0.05 of solar.

In retrospect, it may be that the previous programs have been conducted backwards, *i.e.* it makes more sense to look for star formation regions in galaxies suspected of low abundance rather than vice versa. This above statement may appear fatuous by reason of the fact that one does not know, *a priori*, where to look for low abundance regions. However, as early as 1968, van den Bergh suggested that the average metal content was a function of total galaxian mass. Lequeux and collaborators³ were the first to show a good correlation between galaxian mass and oxygen abundance for Dwarf Irregular galaxies. Most subsequent studies show a good relation between the total galaxy mass and observed oxygen abundance for irregular galaxies. While this relationship has been challenged by some, a good test is to measure the oxygen abundance in extremely low mass gas rich galaxies.

Thus, in collaboration with J. Melnick (ESO) and M. Moles (Madrid), a spectrophotometric study of the HII regions in GR 8 was undertaken. GR 8 was discovered by Reaves,⁴ in search for dwarf galaxies in the Virgo cluster. The best estimate of its distance gives 1.0 Mpc, making GR 8 a Local Group member. Using a distance of 1.1 Mpc, de Vaucouleurs and Moss,⁵ derive an absolute magnitude of -10.7 , establishing GR 8 as one of the faintest known gas rich irregulars.

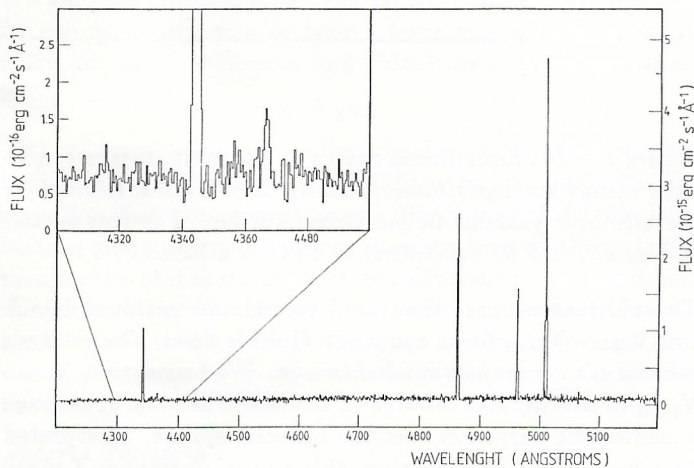


Figure 1 - High resolution IPCS spectrum for the HII region Hodge 2 in GR 8.

The first series of observations were obtained in February 1984 with the SIT vidicon attached to the RC-spectrograph of the CTIO 4m telescope. GR 8 was observed for a total of 5,400 seconds. Unfortunately in these spectra the measurement of the critical [OIII] 4363 Å line was uncertain, due to confusion with the strong Hg I 4368 Å night sky line. Figure 1 shows a 10,000 seconds high resolution spectrum of the HII region Hodge 2 taken with the IPCS in the IDS spectrograph of the 2.5m Isaac Newton telescope of the Roque

de los Muchachos Observatory. As can be seen, the temperature sensitive [OIII] 4363 Å has been clearly detected. The abundance analysis gives an electron temperature of 18,500 K and a relative oxygen content of 0.024 of solar. This is, within the errors, equal to the oxygen abundance in I Zw 18, the lowest abundance HII region known!!

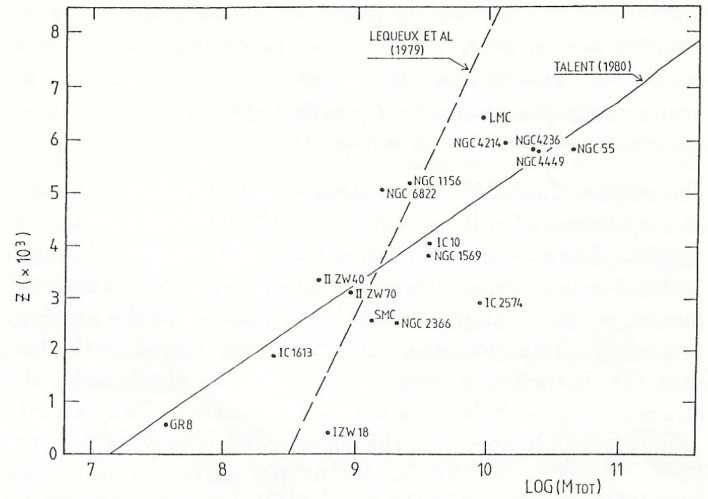


Figure 2 - Plot of Z versus $\text{Log}M_{\text{tot}}$ from Talent PhD Thesis. GR 8 and I Zw 18 have been added. The dashed line represents the relationship derived by Lequeux and collaborators from a different sample of galaxies. The solid line represents the relationship derived from Talent.

In Figure 2 we present a graph of Z (where it is assumed that oxygen represents 45 per cent of Z by mass) versus the total galaxian mass, taken from the PhD Thesis of Talent (Rice University, 1980). We have added values for GR 8 (with a mass from Fisher & Tully,⁶ and I Zw 18 (Z from Davidson and Kinman,⁷ and mass from Lequeux and Viallefond⁸). The broken line shows the original correlation of abundance and mass from Lequeux *et al* (1979). The solid line shows the correlation derived by Talent from the displayed data. The position of GR 8 in this diagram lies very closely to that predicted by the relationship of Talent. This is a strong confirmation of the relationship between abundance and total galaxian mass for irregular galaxies.

Figure 2 strongly demonstrates the need for more observations of the oxygen abundance in very low mass gas rich irregular galaxies. It is possible to argue that the x intercept of the Z versus $\text{Log}M_{\text{tot}}$ diagram may represent the Jeans mass just after recombination in the early universe.

Confidence in the abundance-mass relationship for irregular galaxies may speed up the process in determining the primordial helium abundance and lead to a better understanding of the evolution of dwarf irregular galaxies.

R Terlevich
and E Skillman (Dwingeloo)

- 1 Kunth & Sargent, 1985, *Astrophys. J.* **300**, 496
- 2 Kunth & Sargent, 1983, *Astrophys. J.* **273**, 81
- 3 Lequeux, 1979, *Astron. and Astrophys.* **80**, 155
- 4 Reaves, 1956, *Astron. J.* **61**, 69
- 5 Moss, 1983, *Astrophys. J.* **271**, 123
- 6 Fisher & Tully, 1975, *Astron. & Astrophys.* **44**, 151
- 7 Davidson & Kinman, 1985, *Astrophys. J. Supl. Ser.* **58**, 321
- 8 Lequeux & Viallefond, 1981 *Astron. and Astrophys.* **243**, 127

STREAMING MOTIONS IN THE LOCAL UNIVERSE

The evidence provided by the integrated MicroWave Background (MWB), the radio source counts and deep galaxy counts, indicates that the universe is highly isotropic and smooth at very large scales. On the other hand, it is decidedly clumpy at scales of tens of megaparsecs. These days this clumpiness is described as being topologically similar to filaments, sheets, bubbles or sponges, according to the taste of the author. In any case, the presence of such structure naturally raises the question of whether the Hubble flow shows systematic departures on similar scales.

The source of the MWB radiation is considered to be matter at very large red shift ($z > 1000$) which last scattered the radiation. The dipole distortion in the MWB found by Smooth and Lubin in 1979, is interpreted as a reflex of the "absolute" motion of the local group of galaxies relative to the universe as a whole. This conclusion is strongly supported by the fact that the distortion is very nearly a "pure" dipole field, the quadrupole part being less than a few percent. This remarkable result indicates that the local group is moving towards $l=268$, $b=27$ at 600 km/s. About 300 km/s of this motion is toward the Virgo cluster of galaxies, comparable to the "infall" motion of the local group toward Virgo, suggesting that the entire motion of the local group might be due to gravitational perturbations.

Many of the recent studies of the velocity field in and around the local supercluster assume that any departure from a smooth Hubble flow is due to a gravitational perturbation. In a Friedman-Lemaître universe the peculiar velocity of a particle in a spherical gravitational potential is

$$V_{pec} = \frac{2GdM}{3H_0R^2\Omega^{0.4}} \\ \sim 50dM_{12}R_6^{-2}h^{-1}\Omega^{-0.4} \text{ km/s}$$

where Ω is the cosmological density parameter, G is the gravitational constant, H_0 is the Hubble constant and dM is the mass excess within the radius R . The peculiar velocity is expected to decrease with the square of the distance from the cluster center. If so, the local group of galaxies should show a peculiar velocity relative to a distant galaxy frame similar to the peculiar velocity relative to the MWB. Furthermore both reference frames (MWB and distant galaxies) should be at rest with respect to each other.

This scenario has been recently used by Sandage and Tamman and by Aaronson and collaborators. They found that, in order to reconcile the motion of the local group with respect to the MWB and the measurements of the infall towards the Virgo cluster, it is necessary to postulate a density perturbation at a redshift of about 3,000 km/s in the direction of the Hydra-Centaurus supercluster. This perturbation is pulling the Virgo system and the local group simultaneously. Until now, however, there have been too few data for the Hydra-Centaurus supercluster to test this model.

In collaboration with D. Burstein (A.S.U.), R. Davies (KPNO), A. Dressler (M.W.L.C.O), S.M.Faber (Lick Obs.), D. Lynden-Bell (IOA) and G. Wegner (Dartmouth Coll.) I started in 1981 the most complete survey of intrinsic properties of elliptical galaxies ever done: with a total of 574 elliptical galaxies it covers the complete sky and includes a

volume of about 10,000 km/s in diameter. After five years of hard work the survey is now completed. It provides accurate central velocity dispersions, radial velocities, line strengths, magnitudes, colours, sizes and axial ratios for 423 galaxies.

Spectra obtained by us for each galaxy were analyzed using Fourier or power spectrum techniques to yield central velocity dispersions good to better than 10%. Photometry of the galaxies was done using photoelectric aperture measurements and/or CCD photometry. At least 3 apertures per galaxy were used. Magnitudes, sizes and colours are good to better than 5%.

A new accurate distance estimator was found. It is based on a very tight correlation between surface brightness, velocity dispersion and radius. The scatter in this relation implies an accuracy in distance measurement of better than 25% per galaxy, comparable to the infrared Tully-Fisher method for spirals. This can be seen in Figure 1 where the relation between the radius at constant surface brightness ($SB=20.75\text{mg}$) and central velocity dispersion is plotted for the elliptical galaxies in the Coma cluster.

Coma Cluster Ellipticals

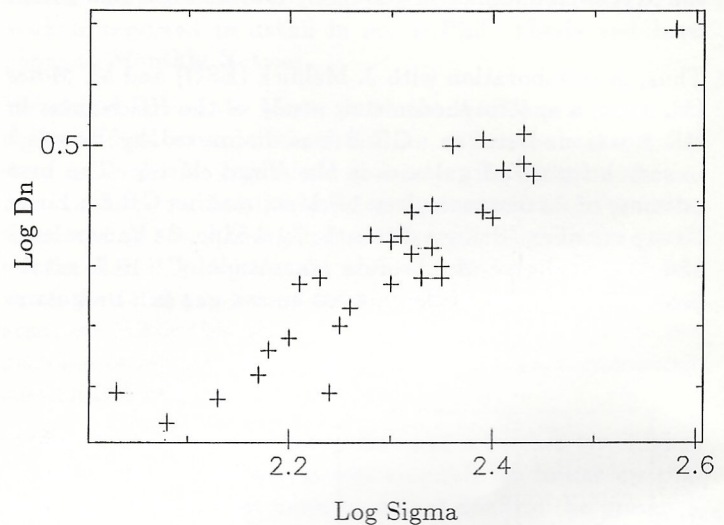


Figure 1 - The logarithmic radius at constant surface brightness versus the logarithmic velocity dispersion is plotted for the elliptical galaxies in the Coma cluster. The rms scatter in Log D_n is 0.07 equivalent to 17% in distance.

These distances were then used to estimate residual velocities $V_{obs} - V_{pred}$ from a smooth Hubble flow. The analysis showed a very important behaviour. We found that $V_{obs} - V_{pred}$ in coordinates relative to the MWB standard, exhibits a systematic variation over the celestial sphere. Interpreted as a large scale bulk motion, this variation implies a mean motion of the ellipticals with respect to the MWB of 500-600 km/s in the direction $l=309$, $b=6$.

It was surprising for us to find that the massive Hydra-Centaurus supercluster also participated in the flow with a bulk motion of about 1,000 km/s with respect to the MWB. Other large structures like Perseus-Pisces supercluster at a distance of 5,000 km/s and opposite in the sky to the Hydra-Centaurus supercluster, also participated in this bulk motion (see Figure 2). This important result implies a bulk flow of all ellipticals over a large volume out to at least 6,000 km/s of 500-600 km/s. Such bulk motion over such a large volume of the universe raises severe cosmological questions about the

ability of gravity to induce large-scale perturbations. Alternatively, a large mass concentration of about 20 times the mass of the Virgo cluster of galaxies, located near the Galactic plane in the direction of Centaurus at a distance of about 4500 km/s could explain even better the data without requiring a bulk motion for the sample as a whole.

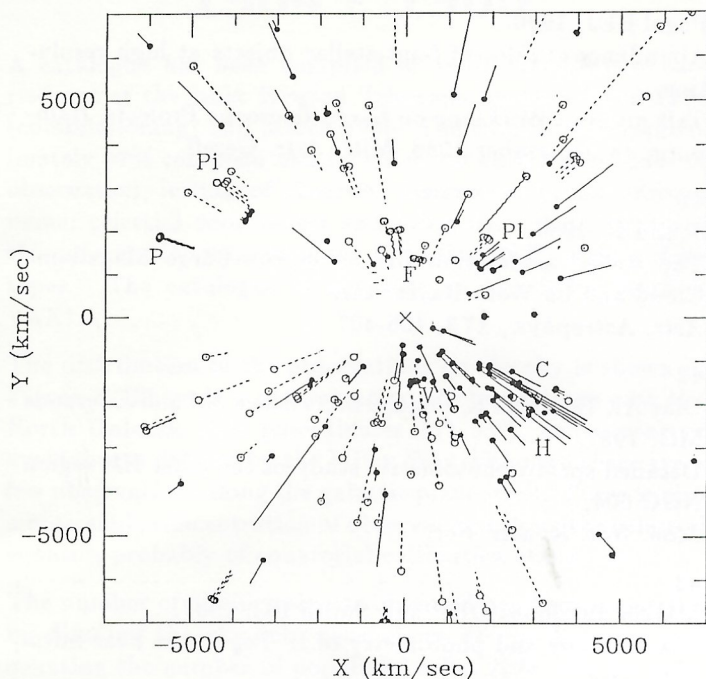


Figure 2 - The residual velocities from a smooth Hubble flow for the elliptical galaxies in the sample within 45 deg. of the Supergalactic plane projected into the plane as viewed by an observer at the position of the local group \mathcal{G} at rest with respect to the microwave background radiation. The dot or circle marks the predicted distance in velocity units for each galaxy, and the vector shows whether the galaxy is receding (solid) or approaching (dashed) more rapidly than expected in a smooth, uniform flow. The Hydra-Centaurus Supercluster can be clearly seen to have a large bulk motion of about 1,000 km/s. Also Perseus and Pisces are seen participating in the bulk motion.

Is there some huge, yet undiscovered concentration of mass behind Hydra-Centaurus and hidden by the Galactic obscuration but not present in the IRAS maps? Is this bulk motion some relic of whatever process formed the galaxies making the MWB standard of rest different from that determined from the Hubble flow? At this stage nobody knows, but I believe that we are at the verge of new discoveries that would change the way we understand and model the nearby universe.

Roberto Terlevich

THE USNO FLOPPY ALMANAC

The 1987 Floppy Almanac has been produced by the Nautical Almanac Office of the US Naval Observatory.

It is a package of software and data to full precision covering many sections of the Astronomical, Nautical and Air Almanacs. The program is menu driven, and the options include both positional and physical data interpolated to any date and time within the appropriate year. For example it will produce the geocentric apparent places of the Sun, Moon, Planets and bright stars, the heliocentric positions of

the planets, the mean and apparent Greenwich sidereal time. The Floppy Almanac also contains several catalogues including a catalogue of the 1536 stars in the FK4. It is also possible for users to create their own catalogue of special stellar objects. Software is included for calculating topocentric information, and navigation information suitable for sight reduction.

The Floppy Almanac is available for use on IBM type personal computers as well as RGO's STARLINK and VAX 11/750 computers. To use the version on either of the RGO's computers just login and type FA87 and press return.

The floppy disc for the IBM version is a 5¼ inch 360K diskette which contains the software and data and will run on an IBM PC, PC-XT, PC-AT and compatibles with at least 256K of memory under the MS-DOS operating system. The disc called 1.3C is for use with a coprocessor, whilst 1.3P is the standard PC version. Discs for 1987 and a user guide are now available from the RGO librarian. The price including postage, packing and VAT is £15.00.

In the NAO we are now working on producing almanacs on a BBC floppy disc for the Star Almanac for Land Surveyors and for Compact Data for Astronomy and Navigation. These data will be to lower precision but the period of validity will be five years. We hope HMSO will market these discs and convert them to IBM versions.

BD Yallop

CY Hohenkerk

RGO PREPRINT SERIES

The following RGO Preprints have appeared since GEMINI No. 15.

22

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LA PALMA

I.N.T. Observations 1984 - 1986

A catalogue has been compiled of 16522 integrations carried out at the Isaac Newton Telescope between April 1984 (commissioning) and March 1986. The catalogue is approximately 97% complete and includes, for each frame: date of observation; initials of observer; instrument in use; object-name; celestial coordinates and integration time. Most of this information was extracted from the I.N.T. archive data tapes. The catalogue is available on the RGO Starlink VAX†.

The distribution of the observations on the sky is shown in Figure 1. There is a concentration of observations near the North Galactic Pole (coordinates $13^h, 35^\circ$), and a zone of avoidance is defined by the Milky Way, although there are a few observations along the galactic plane itself. There is also a noticeable concentration of observations along the celestial equator, probably of equatorial calibration standards.

The number of distinct objects observed has been estimated by dividing the sky into cells about $10'$ in diameter and counting the number of populated cells. 2276 cells are populated by one or more observations. The largest number of observations of any one object was of **IP Peg**, observed 238 times.

The cells have been ranked according to the total amount of integration time expended on each. The occupants of, and time in hours expended on each of the 10 top-ranked cells are as follows:

Object-name	T_{obs}
B2 1225+317*	23hrs
3C 120	17
NGC 4151	17
NGC 1275	13
Q 0014+813*	12
IP Peg*	11
PG 1700+518	11
MKN 3	10
3C 345	10
A 0620	9

where an asterisk indicates one observer only. Integrations on extragalactic objects predominate over those on galactic objects in the ratio 3:2, and clearly dominate the Top Ten.

A detailed statistical analysis of the catalogue is being prepared for publication. In the meantime, astronomers planning observations with the I.N.T. may be interested to know the way in which time on an average night has been used, as a guide to the realistic integration time available on average:

$3^h.4$	integrations on astronomical targets
$0^h.2$	integration on ARCs, FLATs etc.
$2^h.6^*$	time lost through technical problems or unusable weather
$2^h.9^{**}$	remaining time (between individual exposures)
$9^h.1$	mean astronomical night (elevation of sun $< -18^\circ$)

* Technical problems accounted for about $1^h.0$ and weather for about $1^h.6$ of the $2^h.6$ 'time lost' in the table, according to the logbooks.

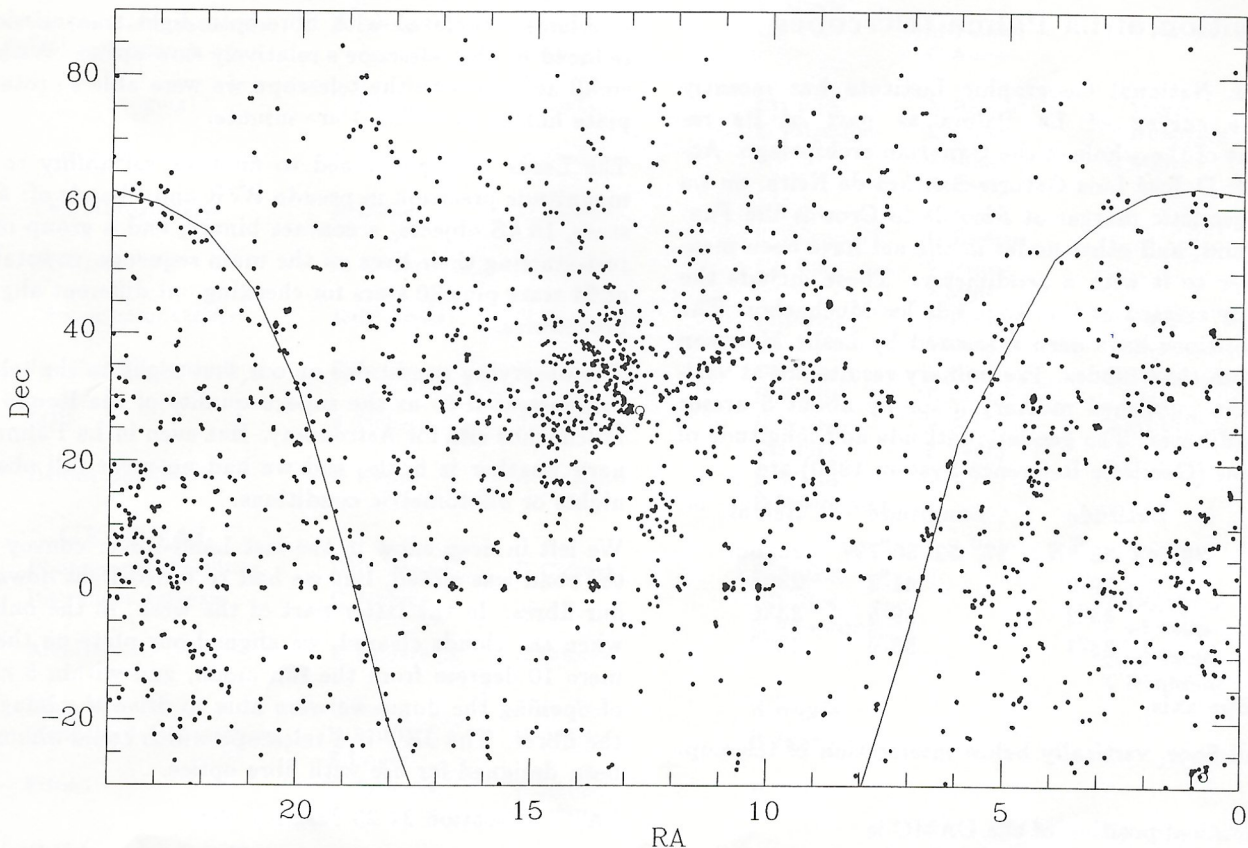


Figure 1 - The distribution of INT observations on the sky. The open circles and solid curve mark the galactic poles and plane.

** The 2^h:9 'remaining time' corresponds to an average of 9 minutes per observation. Much of this time elapses while the observer attempts to set the slit on faint objects, some while he reads out data and a little while he changes the equipment configuration, for example to record an arc exposure or change a grating or rotator position angle. Some may also be time lost during short-lived technical problems (e.g. computer down-time) which had not been recorded in the telescope logbooks and therefore were not included as such in the above table.

We thank Chris Hebson and Doreen Oliver for their help in compiling the catalogue.

Chris Benn & Ralph Martin SEE STOP PRESS p.29

† There are three versions of the catalogue on the VAX, in: INTOBSCAT:OBSERVATIONS.LIS (ordered by tape number)

INTOBSCAT:POSITIONS.LIS (ordered by RA)

INTOBSCAT:OBJECTS.LIS (ordered by object-name)

Astronomers wishing to obtain copies of data from the archive should contact Bill Martin at RGO.

La Palma Archive

The SERC-ZWO Joint Steering Committee is reviewing the arrangements for release of La Palma data to the general public, with the possibility that the proprietary time in which the observer has its exclusive use will be set at one year. Meanwhile, as already established, RGO will make available, from the archive, on request, data which is more than two years old at the date of the request.

Requests for such data should be addressed to Bill Martin RGO, who will arrange for a copy of the relevant tape to be sent. Depending on the number of requests, it might be necessary to review this free service, e.g. by asking for blank tapes on which to load data from the archive.

Paul Murdin

Position of La Palma telescopes

The Spanish National Geographic Institute has recently completed a survey of La Palma as part of its re-measurement of the whole of the Canarian archipelago. According to Sr D José Luis Caturia Sanchez de Neira, on La Palma the geodetic marker at Pico de la Cruz is the Fundamental Point, and other nodes in the net have been measured relative to it with a geodimeter. These include the pillar recently erected at the Roque de los Muchachos. The telescope positions have been measured by Leslie Morrison as offsets from these nodes. Preliminary results are at variance with the published military maps by about 5 arcsec in both coordinates. The geodetic latitude and longitude of the telescopes (Geodetic Reference System 1980) are

	Latitude	Longitude	Height
CAMC ¹	28° 45' 35"8N	17° 52' 56"7W	2326m
JKT ²	39"9	41"2	2364
INT ²	43"2	39"5	2336
WHT ²	38"1	53"9	2332

1. Telescope axis
2. Ground floor, vertically below intersection of telescope axis.

The astronomical position of the CAMC is
28° 45' 52"4N, 17° 53' 07"8W,
defined by the local vertical, which shows a considerable discrepancy with the geodetic position of (+16"6, +9"7),

equivalent to 500m. The explanation of this discrepancy is not clear but deflections of the vertical of this size due to the gravitational attraction of the local structure of mountains are not unknown in isolated islands (Helmer & Morrison, *Vistas in Astronomy*, 1985, 28, 506).

The telescope positions tabulated are the most accurate and suitable which are presently available to define their positions relative to astronomical phenomena (e.g. pulsar timing relative to the solar system barycentre etc).

Paul Murdin

FIRST LIGHT WITH FIBRE OPTICS on the JACOB KAPTEYN TELESCOPE

The JKT was conceived in the days when photography was the medium for imaging the Universe. The Leeds Astrophysics Group were convinced that by using the new technology of CCDs and fibre optics, the photographic capability of the JKT could be used to increase the photometric and spectroscopic productivity of the telescope. We used a photograph as a template for placing fibre optics in the image plane of the JKT and fibres placed over the clear images of the stars. The positive plate with its fibres is replaced in the telescope, and the starlight disappears down the fibres as the telescope is aligned into its original position. The UK Schmidt Telescope in Australia has a similar strategy.

In reality the alignment is difficult. The fibres are about a tenth of a millimetre in diameter and the plate must be realigned in RA and declination to a few arc seconds. The plate also requires a rotational realignment to about 3 arc minutes. Compared with other telescopes the JKT is very well suited to fibre optics. The Cassegrain focus is accessible and rotatable unlike a Schmidt Telescope. It has an f/8 focus which produces a 90 arc minute field on a scale of 25".6 arcsec/mm. A five arcsecond aperture is produced by easily manipulated and readily available fibres and the more subtle problems associated with fibre-optic light transmission are reduced by the telescope's relatively slow optics. With some small additions to the telescope we were able to rotate the plate holder to within 1 arc minute.

The Leeds Group planned to monitor variability to millimagnitude precision in pseudo BVR and I bands of: δ Scuti stars, IRAS objects, a contact binary, and a group of stars just starting their lives on the main sequence, in total a list of 64 stars plus 20 stars for checking out different alignment procedures.

The observing conditions on our first night on the telescope demonstrated to us the superb quality of the Roque de los Muchachos site for Astronomy. But even in La Palma, January weather is fickle, and we had no more full observing nights or photometric conditions.

We left in deep snow in the last Land-Rover convoy before the road was closed, but we had recorded light down all of our fibres. In the latter part of the week, in the only hour when the clouds cleared, we aligned our plate on the sky a mere 10 degrees from the full moon, and within 5 minutes of opening the dome we were able to drive the images into the fibres. The JKT is a telescope which could almost have been designed for use with fibre optics.

PATT allocation 21-28 January 1986

John Baruch, Ashley Clarke, Keith Jones, Peter Johnson
University of Leeds, 1.2.86

LA PALMA INSTRUMENT SPECIALISTS
(with effect from April 1 1987)

The following people are the first line of contact in case of astronomical, technical or software query about a particular instrument.

Instrument	HERSTMONCEUX and UK/NL Community		LA PALMA		
	ASTRON.	TECH.	ASTRON.	TECH.	SOFTWARE
INT					
Telescope (a) Optics	R Laing	S Worswick	R Argyle, R Wallis	-	-
(b) Mechanics, software, and performance	R Laing	N Snodgrass, S Atkinson, R Laing	CD Pike	M Fisher, C Amos	MP Fisher
Cassegrain Acquisition	R Laing	D Gellatly, S Worswick	CD Pike, E Valentijn	E Penny, M Freeman	T Dimbylow
TVs, autoguiders,	R Laing	D Thorne	CD Pike, E Valentijn	C Amos, K Herbert	
Cassegrain IDS	E Zuiderwijk	D Gellatly, S Worswick	E Valentijn†	E Penny, M Freeman	T Dimbylow
FOS	R Terlevich	N Waltham	E Valentijn†	E Penny, K Herbert	T Dimbylow
CCDs (spectrograph)	R Terlevich	P Jordan	CD Pike, E Valentijn†	K Herbert, E Penny	C Mayer,
(imaging)	E Brinks		CD Pike, E Valentijn	K Herbert E Penny	C Mayer
IPCS	C Jenkins, E Zuiderwijk	J Dick	R Wallis, E Valentijn	M Fisher, C Amos	T Dimbylow
TAURUS 1	S Unger		E Valentijn	R Pit, H de Graaf	T Dimbylow
Prime Focus	P Murdin	W Bracey	R Argyle	E Penny, K Herbert	T Dimbylow
Photographic Camera	P Andrews	N Snodgrass	R Argyle	E Penny, J Mills	
Fibres	R Schild	-			
Peoples' Photometer	DHP Jones	D Gellatly	CD Pike, R Wallis	R Pit, E Penny	CD Pike
Manchester Echelle Image sharpening/ & interferometry	J Meaburn T Marsh	J Meaburn J Noordam A Greenaway	R Wallis R Argyle		
JKT					
Telescope (a) Optics	DHP Jones	S Worswick	R Wallis, R Argyle	-	-
(b) Mechanics, software, and performance	R Laing	N Snodgrass, S Atkinson, R Laing	CD Pike	M Fisher, C Amos	MP Fisher
CCDs (imaging)	E Brinks	P Jordan	CD Pike, E Valentijn	K Herbert, E Penny	C Mayer, T Dimbylow
Cassegrain Acquisition	R Laing	P Jordan		J Mills, E Penny	C Mayer
TVs, Autoguiders	R Laing	D Thorne	CD Pike, E Valentijn†	C Amos, K Herbert	
RB Spect.	R Edwin	R Edwin	CD Pike	E Penny, J Mills	
Photographic Camera	DHP Jones	N Snodgrass	R Argyle	E Penny, J Mills	CD Pike
Peoples' Photometer	DHP Jones	D Gellatly	CD Pike, R Wallis	R Pit, E Penny	CD Pike
MPF	J Tinbergen	J Tinbergen	R Wallis, CD Pike	R Pit, E Penny	P vd Velde
Belfast Echelle	B Byrne	C McKeith	R Wallis, E Valentijn†		
GENERAL					
Photographic Facilities	DHP Jones	D Calvert	R Argyle		
Instrument software	C Jenkins	-	CD Pike, E Valentijn†		T Dimbylow, P vd Velde
Archive	E Zuiderwijk	D Hobden			P vd Velde, T Dimbylow
Library	R Laing	J Dudley	R Argyle		
Manuals, documentation	E Brinks S Unger	W Martin	R Argyle		
Filters	R Terlevich	P Jordan	R Argyle, CD Pike		

†E Valentijn or R le Poole

ADDITIONAL ISLAND FACILITIES

	TECHNICAL	SOFTWARE	TECHNICAL	SOFTWARE
Time Service	J Mills, C Amos		Computer Networks	M Freeman, H de Graaf
Computers:			PADs	M Freeman, H de Graaf
INT Instrumentation Computer	M Freeman, H de Graaf		Radio Communications	J Mills, R Pit
INT Control Computer	M Freeman, H de Graaf	MP Fisher		
Engineering Computer	M Freeman, H de Graaf		General Software	
JKT Instrumentation Computer	H de Graaf, M Freeman		ADAM	T Dimbylow
JKT Control Computer	H de Graaf, M Freeman	MP Fisher	ADAM Utilities	P vd Velde
Starlink Vax	M Freeman, H de Graaf	S Perceval*	Bulk Data system	P vd Velde
WHT Control Micro-VAX (appropriate)	M Freeman, H de Graaf	RW Abraham	Packet Conversion software	T Dimbylow, C Maskall
			Graphics	

* From the end of April.

Paul Murdin

Summary of CCDs on La Palma

CHIP	CAMERA	OPERATIONAL DATES	BIAS LEVEL	READ NOISE	e-/ ADU	Max Counts	IMAGE FORMAT	Notes
RCA 501EX	RCA (PF)	July 1985 - date	~1300	16	3.8	>60K	320x512 30x30 um	
GEC P8603	FOS	May 1985 - date	~150	7	1	27K	385x578 22x22 um	
GEC P8603	GEC1 (IDS)	June 1984 - Dec 1986	~140	6 12(pf)	0.8	40K	..	1.
GEC P8603	GEC1	Feb 1987 - date	~100	8.5	~0.8	>30K	..	2.
GEC P8603	GEC2 (JKT)	Sept 1985 - March 86	~100	6	~1	~30K	..	3.
GEC P8607	GEC2	July 1986 - Nov 1986	~100	5	1.6	35K	385x578 22x22 um	4.
GEC P8603	GEC2	Nov 1986 - date	~200	6	~1.6	>60K	385x578 22x22 um	5.

NOTES:

1. Chip s/n = 2047/12/9 as originally fitted to IDS Camera. A nominal preflash (pf) was routinely used here. This required repair in Oct/Nov 1984 (Chip electronics was reset). From Oct 1986 chip performance was poor, leading to its replacement.
2. Chip s/n = 2076/10/8. Less preflash apparently needed than before. LPO staff replaced this chip; not all parameters precisely known yet.
3. Chip s/n = 2046/7/10 A-grade originally fitted to this camera. The camera was returned to RGO for repair in March 1986; subsequently a new chip was fitted.
4. Chip s/n = 2590/8/26. This is a 3/4 scaled chip which was used as a temporary replacement in the JKT camera.
5. Chip s/n = 2076/10/8. This normal sized chip was fitted to the JKT Camera in Nov 1986. No preflash should be necessary normally.

Typical digitised areas exceed the size of the active image area; e.g. 350x512 for RCA camera, and 400x590 for GEC Cameras.

The maximum available digitised count is always 65535.

In the above table BIAS LEVEL, READOUT NOISE & MAX. LINEAR SIGNAL are quoted in ADU's (Analogue-Digital converter Units).

Paul Jorden

TAURUS ETALON PARAMETERS (N=35)

The table below gives the current etalons and filters available for use with TAURUS I on the INT.

TAURUS I ETALONS:

Etalon No.	Gap (μm)	Wave-length (\AA)	Useful Wavelength Range (\AA)	Free Spectral Range*		Resolution		Principal Application
				(\AA)	(km/s)	(\AA)	(km/s)	
1	250	5000	4600-7000	5.0	300	0.14	8.4	Planetary Nebulae; HII regions
		6500		8.4	390	0.24	11	
2	540	6500	5900-7100	3.9	180	0.11	5.1	Planetary Nebulae; HII regions.
3	122	6500	5900-7100	17	800	0.5	23	SNRs (fine structure); Rotation curves of spirals; Velocity fields of irregular interacting and active galaxies.
4	75	5000	4600-7000	17	1000	0.5	29	SNRs (fine structure); Rotation curves of spirals; Velocity fields of irregular interacting and active galaxies.
		6500		28	1300	0.8	37	
5	19	5000	4300-5700	66	3940	1.9	113	SNRs; Seyfert galaxies.

* Free Spectral Range = $\lambda^2 / (2 \times \text{Gap})$
 Instrument FWHM = Free Spectral Range / Finesse
 Finesse is approximately 35.

TAURUS I FILTERS: (Central λ) / $\Delta\lambda$

3737/50	3770/50	4570/320	4770/350
4868/15	4880/100	4883/15	4898/15
4912/15	4963/14	4976/15	5010/100
5012/20	5020/385	5032/20	5052/20
5068/12	5072/20	5092/20	5148/17
5177/14	5230/400	5342/12	5450/430
5700/490	5905/10	5960/470	6230/470
6303/15	6568/17	6610/17	
6631/17	6652/17	6673/17	6689/15
6730/50	6770/50		

New filters: (to replace aged filters)

6566/15	6578/15	6590/15	6602/15
6614/15	5010/15	5022/15	5034/15
5046/15			

Steve Unger

Restrictions to Configuration changes in the INT Cassegrain Spectrographs

The Isaac Newton Telescope's Cassegrain cluster of spectrographs is intended to be versatile and to enable astronomers to deploy instruments easily on a variety of programmes. The Intermediate Dispersion Spectrograph with the 235 and 500 mm cameras is for higher resolution studies of objects, the Faint Object Spectrograph for their lower resolution identification or spectrophotometry. However, the ease of making changes to the spectrograph depends on the particular change envisaged; some can be spontaneous and some need to be planned. This obviously affects your PATT and CAT proposals, and how you execute your observing run. Here are the relevant restrictions:

The possible changes to the Cassegrain cluster are as follows. (Care is required when the IPCS is active: follow approved procedures.)

1. Gratings. All gratings can be removed and inserted in the spectrograph at will in a procedure which takes at most 10 minutes. They can be likewise switched from one camera to another (usually requires grating to be removed, turned upside down and reinserted); but this represents a detector change (see Section 2). Changes to the detector set up (SCAN correction, or ROTATION or FOCUS) are usually not required if a grating is changed, since the gratings have all been carefully set up in their mounts, but there have been known to be exceptional cases.

2. Detectors. The two IDS cameras (235 mm and 500 mm focal length) can accept any of three detectors (IPCS, RCA CCD and GEC CCD). However, a change of detector on a given camera is a scheduled daytime change with considerable consequential adjustment necessary after the change. In addition, CCD cryostats may take 12 hours to pump down and come to operating temperature. Camera changes are therefore determined in the six month schedule on the basis of information you gave in your application for telescope time. RGO is willing to consider unscheduled detector changes for good scientific reasons provided the change and its consequences occur at dates which are suitable for operational reasons. At an absolute minimum, 24 hours' notice of a proposed change is required, and the longer the notice given, the better the chance of success of a request. Three weeks' notice is the practical minimum, in other words before you get to the island. The request should be issued through the support astronomer, and will be authorised only by Keith Tritton (or Jasper Wall from 2 April 1987) or the person he has nominated to act on his behalf in his absence from La Palma.

Amongst the factors which the RGO will take into account when deciding whether to agree to a request for an unscheduled detector change are

- availability of staff skilled in the change, including boring details like whether the day of the week is a weekend or holiday;
- maintenance requirements on the instruments, detectors or telescopes;
- availability of liquid nitrogen for CCDs and the effect on subsequent observers of using the supply of liquid nitrogen.

Although it is readily possible to switch from one camera/detector combination to the other, astronomers who have requested use of one camera should not assume that a complementary combination is automatically available. Amongst the reasons why not are:

- there are now three detectors available, so there is no unique alternative to the one specified;
- liquid nitrogen for CCDs might not be available;
- there might be maintenance requirements;
- it might be necessary to use a detector on another instrument or telescope.

Use of two cameras can only be guaranteed if requested in the PATT application.

The same is true if the astronomer wants to back up the use of the two intermediate dispersion cameras with the Faint Object Spectrograph, or vice versa. The actual change is an easy removal or insertion of a reflecting prism in the spectrograph (1/2 hour change at most). But the FOS CCD chip may not be cold, liquid nitrogen may not be available, or the FOS may have been removed in order to ease a spectrograph change (the spectrograph cannot be handled off the telescope unless FOS is removed).

Astronomers should bear in mind that it is not easy to set up two detectors in the afternoon before the first night. It is recommended to set up the main detector on the afternoon before the first night and the backup on the afternoon before the second.

When another detector is used, the astronomer must switch to the appropriate software system, in a procedure which takes as long as the physical alteration of the spectrograph. The procedure should be rehearsed during the day to avoid time wastage.

3. Slit. The Slit assembly can be replaced by an assembly which accepts the multislit device in order to allow multi-object spectroscopy of clusters of stars or galaxies. To remove or replace the usual slit assembly, the spectrograph must be taken off the telescope. Thus this is a scheduled change, planned in advance, and defined at the six monthly planning of the semester.

Once the usual slit assembly has been removed, and the spectrograph is back on the telescope, the multislit device itself, or the fixed long-slit alternative, can be removed and inserted at will, in a procedure which takes a time yet to be determined under field conditions (15 minutes?). The setup of the multislit device for different fields of objects takes 1/2 to 1 hour and while it is being adjusted the fixed long-slit can be used on a single object (or pair). As soon as can be arranged there will be several multislit devices manufactured to make their use more efficient.

Use of the multislit assembly means that the below slit

filters also have to be exchanged, and there are consequent restrictions on the use of below-slit filters with large field sizes (see FOS manual).

4. Filter slides. With the exception detailed under Section 3, all filter slides can be removed and inserted in the spectrograph at will in a fiddly procedure which takes 5 minutes, provided that the filters have been mounted in the slides beforehand (daytime preparation).

5. Collimator. Three collimators are available in the Intermediate Dispersion Spectrograph, coated for blue, red and a wide-band usage. Whilst the physical change of collimator is an easy change, and the collimators are nominally identical, astronomers should be aware that the spectrograph focus is very sensitive to the position of a strongly figured optical component. The spectrograph focus and, possibly, rotation should be checked if the collimator is exchanged. Since this is likely to take more time than any realistic increase in throughput of the spectrograph will save, a collimator change is practical only as a day-time change, although usually permissible at will. Unless agreed beforehand, it is not allowed to change the collimator if the telescope night is shared amongst users, since the risk to the second user is too high.

6. IPCS. There are numerous switchable options in the IPCS, of frame size, window size, and position, X-gain, X-shift *etc.* . The table describes consequences of changing the IPCS set up.

Changes in IPCS set-up.

Change	Consequential changes	Notes
Frame line resolution	Videogain Scan correction, Flat field, Window, Saturation rate, Wavelength scale	
Frame increment extent	Flat field, Window Saturation rate	1
Window size or position	Flat field	2
X-shift, Y-shift	Scan correction, Flat field	3
X-gain, Y-gain	Scan correction, Flat field, Saturation rate, Wavelength or spatial resolution and coverage	3
X-resolution	Flat field, Window, Saturation rate	
EHT Power OFF/ON	Scan correction, Flat field, Rotation	4

1. Rotation and scan correction both likely to be moved off optimum.
2. Note that the flat fields in the two windows should be the same in the overlap region.
3. Y-shift and Y-gain are not usually permitted to be changed while the IPCS is on the spectrograph.

4. All spectrograph hardware changes (except change of detector between cameras) can be made without powering off the EHT, but only by following the prescribed method.

Paul Murdin

RG0/LA PALMA DOCUMENTATION

Since GEMINI No.15 the following Technical Notes have become available. A full list of Manuals and Technical Notes can be found in LPINFO. DOCUMENTS in MANUALS.LIS or TECHNICALS.LIS. Please contact Bill Martin at Herstmonceux for copies.

TECHNICAL NOTES:

- 32 POINTING OF THE INT AND JKT
R A Laing, 13 August 1985
Shows that the pointing of the INT is adequate, but that the JKT is at present unsatisfactory, due mainly to mirror support problems.
- 33 USE OF LPINFO ON THE VAX 11/780
D E Hobden, 23 September 1985
Describes the use of LPINFO. LPHELP and keywords regarding information about La Palma.
- 34 BLEMISHES IN IPCS FLAT-FIELDS
A R Jorden & R Collyns, 21 October 1985
The method of quantifying the blemishes in IPCS flat-fields is described.
- 35 SPECTRUM OF THE COPPER NEON LAMP ON THE IDS
D L Harmer & R Collyns, 28 November 1985
Plots of the spectrum cover the wavelength region 320 to 970 nm. from IPCS and CCD data taken on the INT.
- 36 TH-A HOLLOW-CATHODE LAMP
M Pettini, 5 September 1985
The Th-A lamp is now available in the A&G unit of the INT and will be particularly useful for high dispersion calibration.
- 37 CCD FILTERS FOR USE ON LA PALMA
P Jorden, 12 December 1985
The specifications and profiles for 24 narrow and broad band filters to be used with the CCD on La Palma are given.
- 38 CCD DATA AND FITS
J V Wall & W F Lupton, 20 December 1985
Incompatibility problems between output data from La Palma CCD, A/D converters, and the FITS standards.
- 39 TELESCOPE CONTROL SOFTWARE: GLOBAL VARIABLES AND CONFIGURATION FILES
R Laing & R Wood, March 1986.
- 40 USING THE JKT CCD CAMERA
P R Jorden, February 1986
The CCD with a GEC chip, is available on the JKT. An interim construction has been arranged, until the final instrument with a dedicated A&G box is completed.
- 41 GEOLOGY AND METEOROLOGY OF SAHARA DUST
Paul Murdin, 25 April 1986
As relevant to La Palma.

- 42 CONTROL SYSTEM FOR WHT
R A Laing, 10 May 1986
Astronomical requirements for control of WHT are discussed, and software outline is proposed. Some notes on project management and commissioning are given.
- 43 STRUCTURED OBSERVING WITH THE WHT
C R Jenkins & R A Laing, June 1986
Consensus reached from various informal meetings between astronomers and tech and s/w groups; object to define how the WHT h/w and s/w should appear to the observer.
- 44 WILLIAM HERSCHEL TELESCOPE - CONTROL SYSTEM OVERVIEW
L Jones, 1 December 1986
Specifies the functional requirements and design of the software components of the WHT.
- 45 FILTER AND CCD CHIP SPECTRAL RESPONSE CURVES FOR USE ON LA PALMA.
C Benn & D Cooper, 20 January 1987
Spectral response curves for RCA and GEC chips, KPNO BVRI and RGO UBVRIZ filters.
- 46 TIMING ERRORS FOR THE IMAGING CCD CAMERAS ON THE INT AND JKT.
R A Laing, 29 January 1987
Various software and hardware faults which have introduced errors of up to one second in the timing of CCD exposures are described and algorithms for correcting some of the exposure times are given. The results of a test of timing accuracy on the INT are described.

Bill Martin

LIST OF LA PALMA MANUALS

Please contact Bill Martin at Herstmonceux for copies or contributions.

The following manuals are available:

- I ADAM MANUAL [version 2.4]
Leslie Bell et al., 1984 December
Describes the rules and principles of the ADAM Command Language together with references to individual commands.
- II IPCS USERS' REFERENCE MANUAL [version 2]
Philip Taylor, Bill Martin, Tony Jorden, 1986 April
Describes the setting up and use of the IPCS as used with the Intermediate Dispersion Spectrograph on the INT, and the application of ADAM to this system.
- III PEOPLES' PHOTOMETER: USER AND TECHNICAL MANUAL [version 1]
Dorothy Hobden, Roy Wallis and Derek Jones, 1984 June 26; 1984 August 10 updated
Describes hard and software use of 1-m photometer.
- IV ADAM FORTRAN PROGRAMMERS MANUAL and PERKIN-ELMER USERS PRIMER
1985 December 1
- V 1-M DARK ROOM MANUAL [version 1]
Bob Argyle, Brian Scales, 1984 July
A guide to the method of processing photographic plates in the 1-m darkrooms.

- VI 1-M CAMERA USERS MANUAL [version 1]
Bob Argyle, 1984 July
- VII SPECTROSCOPY WITH THE IPCS ON THE INT -
A SIMPLE GUIDE [version 2]
Charles Jenkins, 1986 September
- VIII SPECTROSCOPY WITH THE CCD ON THE INT -
A USER GUIDE [version 1.1]
Paul Jordan and William Lupton, 1984 December
- IX INT FAINT OBJECT SPECTROGRAPH - USER
MANUAL [version 1]
Mike Breare, Richard Ellis, Ian Parry, Alan Purvis,
Nick Waltham, 1985 May
- X PEOPLES PHOTOMETER ACQUISITION SOFT-
WARE (PPAS) [ADAM version 2.1]
David Pike, 1986 September
- XI JKT USER GUIDE
1986 September
- XII THE ST ANDREWS RICHARDSON-BREALEY
SPECTROGRAPH USER MANUAL [version 1]
R Edwin (St Andrews), 1985 September
- XIII USER'S GUIDE TO THE PRIME FOCUS CCD ON
THE INT
J V Wall, R A Laing, 1986 March
- XIV USING THE MULTISLIT UNIT AT INT CASS [ver-
sion 1.1]
Richard Ellis, Alan Purvis, David Gellatly, Ian Parry,
Warrick Couch, 1986 April

La Palma telephone numbers

From the UK, all numbers are preceded by -010 (the inter-
national network) -34 (Spain) -22 (Tenerife Province).

Sea Level Office in Santa Cruz de la Palma:

010-34-22-4110-05

010-34-22-4114-48

Mountain top: all lines except the Swedish group number are
routed through the switchboard during normal office hours.

Outside these hours the lines are connected as follows:

010-34-22-4000-00	INT
010-34-22-4000-50	Officer in Charge
010-34-22-4000-51	JKT
010-34-22-4000-26	CAMC
010-34-22-4000-75	WHT
010-34-22-4000-82	Residencia
010-34-22-4000-16	Swedish Telescope Group

Service schedule Semester L, La Palma

PATT invites requests for service observations in semester L
on La Palma. The available dates and equipment are listed
below. Requests should give information on what is to be
observed and how the success of the observations should be
judged. Observations will be made by support astronomers.
Some of the nights are already allocated by PATT.

Address requests to both:

Dr K P Tritton	and Dr J V Wall
Royal Greenwich Observatory	Royal Greenwich Observatory
Herstmonceux Castle	Apartado 321
Hailsham BN27 1RP	Santa Cruz de la Palma
East Sussex	Tenerife
	ISLAS CANARIAS

Date	Moon	Instrument
INT		
5 Apr	Q1	Prime focus camera + RCA CCD
7 May	F	Taurus
19 May	Q3	IDS (CCD+235; IPCS+500; FOS)
26 May	N	Ditto
27 May	N	Ditto
31 May	Q1	CCD+500; IPCS+235; FOS
7 Jun	F	Ditto
14 Jun	F	CCD+235; IPCS+500; FOS
16 Jun	Q3	Ditto
19 Jun	Q3	Ditto
4 Jul	Q1	CCD+500; IPCS+235; FOS
19 Jul	Q3	CCD+235; IPCS+500; FOS
27 Jul	N	Prime focus + RCA CCD
JKT		
27 Mar	N	camera (GEC CCD)
28 Mar	N	camera (GEC CCD)
21, 22 Apr	N	camera (RCA CCD)
30-2 May	N-Q1	camera (RCA CCD)
26 May	N	camera (RCA CCD)
3 Jun	Q1	camera (either chip)
11-12 Jun	F	camera (GEC CCD)
20 Jun	Q3	camera (either chip)
28 Jun	N	camera (RCA CCD)
13-14 Aug	F	camera (RCA CCD)

Subject to change of schedule.

Paul Murdin

INT/JKT Instruments/Detectors available or planned to be available for Semester M. (September 1987 - February 1988)

The following instruments and detectors will be available for
Semester M, subject to commissioning, etc., as stated below.

Focus	Instrument	INT Detector	Chip
Cass	IDS (235/500	IPCS	-
..Cameras) ¹	CCD	GEC/RCA
..	FOS ¹	CCD	GEC
..	TAURUS I ²	IPCS	-
..	Peoples Photometer ³	-	-
..	Imaging Box ⁴	IPCS/CCD	-
..	Manchester echelle spectrograph ⁵	IPCS	-
Prime	Direct Imaging	CCD	RCA/GEC

1. Multislit unit available.
2. Service mode only for TAURUS I.
3. Only one PP for two telescopes.
4. See Note (a) below.
5. By arrangement with John Meaburn (Manchester).

Focus	Instrument	JKT Detector
f/15	People's Photometer ¹	-
..	Multi-purpose Fotometer ⁴	-
..	Spectrograph	Pg Plates ⁶
..	Direct Imaging ²	CCD with GEC or RCA chip
..	Belfast Echelle Spectrograph ⁵	RCA/GEC
f/8	Wide Field Camera ³	Pg plates, Nitro- gen sensitising

1. Only one PP for 2 telescopes.
2. Visual guiding. No U or B response. (See Note (h)
below).
3. See Note (f).
4. Now upgraded to 12 channels. (See Note (e) below.)

5. By arrangement with Brendan Byrne (Armagh).
6. Possibly with CCD Camera: consult Roger Edwin (St Andrews) for the latest estimate of availability in Semester M.

NOTES

INT

(a) Imaging Box

The RSRE Imaging Box was successfully commissioned on the INT in February 1987. This instrument is essentially a precision optical bench with mounts (which match the Ealing mini-bench system). Any detectors which match these mounts may be used, e.g. IPCS (including manual shutter) or CCD. Optical components must be supplied and fitted (with technical assistance) by the users.

The Imaging Box is available for common use from Semester M. Alan Greenaway is in the process of providing a full report on the Imaging Box, but in the meantime he or Jan Noordam may be consulted at RSRE Malvern (Tel UK: 06845 2733 Ext 3390) or RGO (Tel. UK: 0323 833171 Ext 3265) respectively.

(b) Cass Imaging

Direct Imaging at Cass on the INT will not be available until further notice, except through the RSRE Imaging Box.

(c) INT Tracking and Pointing

Pointing rms ~ 4 arcsecs, Cass and Prime short-term tracking stability $\sim \pm 0.3$ arcsecs (with no autoguider). With the autoguider it tracks to < 0.2 arcsecs for long periods at both focal stations. Offsetting in Declination is currently inaccurate at the 1-3 arcsec level.

(d) Autoguiders

Cass and Prime autoguiders are now fully commissioned.

JKT

(e) MPF

The MPF now has its full complement of 12 channels. This includes a set of 50/50 and 90/10 neutral beamsplitters and a selection of dichroics and filters. Photometry and linear polarimetry are now possible in up to 12 simultaneous pass-bands between 360 (will become 310 in the not too distant future) and 870 nanometers. Line index photometry in up to 6 lines simultaneously is another option.

At present, MPF is available on JKT only. A recent status report exists, which lists available filters and dichroics. The Users Manual is 95% complete. In preparation is a document to guide the prospective user in the choice between MPF and the Peoples Photometer. For any of these documents, contact Bill Martin at RGO in the first place.

(f) Wide Field Camera

The f/8 Photographic Camera was proved in Semester L. Autoguider available.

(g) JKT Tracking and Pointing

Pointing ~ 12 arcsec rms.

(h) Autoguiders

Autoguiding is available at f/8. CCD (f/15) guiding is done using the Grinnell TV via a dichroic mirror which means response only for $\lambda > 500$ nm (i.e. no U or B band). However, if the system is used without the dichroic mirror, then U and B can be obtained (with the RCA chip) but no guiding is possible.

CCD CHIPS

GEC. The unthinned GEC chip has a peak QE of 35% (i.e. no U band response and weak modified B band response. ($500 < \lambda < 1100$ nm).

RCA. The thinned RCA chip has a peak QE of 80%.

CCD FILTERS

Broad band (Glass, 50mm x 50mm square, 7mm thick)

One set for each CCD camera

U: 5mm CuSO₄ + 2mm UG1 (25mm square)

B: GG385/1 + BG12/1 + BG18/1 + KG3/2 + WG280/2

V: GG495/2 + BG18/2 + KG3/2 + WG280/1

R: KG3/2 + OG570/2 + WG280/3

I: RG9/3 + WG280/4

Z: RG850/4 + WG280/3

Also two sets of Kitt Peak BVRI filters (50mm x 50mm square and 3mm thick). (One V filter is 5mm thick). Wavelengths are:-

	RGO		KPNO	
	λ_c	$\Delta\lambda$	λ_c	$\Delta\lambda$
U	3600	620	-	-
B	4350	1060	4400	1100
V	5350	940	5470	940
R	6450	1500	6460	1260
I	~ 8400	~ 2000	8300	1810
Z	~ 9300	~ 1500	-	-

Narrow band

(One set, 50x50mm square, 9mm thick)

	λ_c	$\Delta\lambda$	Line
	3731Å	52Å	OII
	4075	30	SII
	4691	49	HeII
	4866	51	H β
	5012	50	OIII
	5881	46	HeI
	6306	53	OI
	6556	60	H α
	6590	16	NII
	6730	48	SII
	7331	46	OII
	9075	54	SIII
	9539	52	SIII
	10837	114	HeI

Red shifted H α Filters

(One set, 50x50mm square, refractive index 2.1, blocking UV to 1.1 μ m)

Scan	λ_c	$\Delta\lambda$
	6563Å	53Å
	6607	53
	6652	49
	6700	53
	6742	47
	6789	53
	6835	50
	6877	53
	6925	50
	6970	51

Note. No narrow band continuum filters yet.

W L Martin

CONFERENCE REPORT

OPEN-WINDOW DETECTORS FOR UV ASTRONOMY

A recent workshop at Herstmonceux Castle on 17-19th November 1986 brought together some 40 leading experts from all over the world to study **Open-window Detectors for Ultraviolet Astronomy**. Workshop participants undertook scientific and technical discussions of detector concepts and designs for the wavelength region 100-2000Å. The meeting was particularly timely in the context of two potential space projects in this wavelength region: *SOHO* which is directed toward solar observations and *Lyman*, a proposed Far and Extreme Ultraviolet observatory for cosmic astronomy. The meeting concentrated on the physical principles underlying each detector as well as performance data. Scientists from commercial research laboratories were present as well as those from universities and government laboratories. Described by one participant as the biggest collection of *detector sharks* ever assembled, the meeting also included a leavening of observing astronomers to provide a strong interest in the eventual use of the detectors.

The workshop started with brief overviews of the *Lyman* and *SOHO* missions, covering the general requirements that the foreseen instruments put on detectors. Panoramic photon counting systems are required by both missions. The *Lyman* requirements are most severe for detector size and number of pixels: detectors 15-25 cm in length with a few million pixels are needed. *SOHO* is more demanding in its maximum count-rate requirements: a velocity spectrometer covering the L_{α} line might need to handle 10^6 counts/sec over a few pixels. Both missions would like to push pixel sizes as small as feasible toward $10\mu\text{m}$ pixels and $20\mu\text{m}$ resolution. High quantum efficiency in the wavelength region of interest is always needed but both missions also require good rejection of visible and near ultraviolet light: a ratio in sensitivity of $10^5:1$. There was some mirth however at the application of the phrase *solar-blind* (commonly used in cosmic ultraviolet astronomy) to the *SOHO* detectors.

After this introduction the meeting covered three main topics. The first was microchannel plates and photocathodes. Microchannel plates (MCPs) are leading contenders for the amplification stage in detectors for this wavelength region. Workshop participants heard of ways of decreasing dark-count by removing radioactive potassium from the glass, of new ways of twisting the channels to avoid ion feedback and of the prospects for MCPs with finer bore sizes less than the currently available $8\mu\text{m}$ channel separation. There was considerable discussion of the way MCPs should be prepared by "scrubbing" and bake-out. There is a gain loss after exposure to some 10^9 photoelectrons but, after increasing the voltage to retain the same gain, eventually a stable detector results.

In the ultraviolet the photoelectrons to be amplified in the MCPs must come from a photocathode. Currently the best developed photocathode for the far ultraviolet is CsI. It offers quantum efficiencies at least up to 30% and can be deposited on the web and in the channels of MCPs. The alternative of KBr photocathodes were also discussed at the meeting and these may have a somewhat better quantum efficiency below 1050Å . In addition MgF_2 and CuI may be

useful photocathodes for some *SOHO* experiments. There was much debate as to whether CsI photocathodes on a solid substrate had better quantum efficiency than those deposited on an MCP. The workshop concluded that there was no conclusive evidence in favour of this at present but that the issue needed study.

The second main area covered in the workshop was the way in which the pulses emerging at the back of an MCP or other amplification stage can be read-out. These include wedge-and-strip anodes, coded anodes, multi-anodes, delay-line technology and television techniques. Wedge-and-strip anodes provide an analogue method of locating and centroiding a photon and can achieve very high resolution ($15\mu\text{m}$) in small formats (5mm). Predictions of $20\mu\text{m}$ full width at half maximum (FWHM) resolution over a 50mm detector were made but the wedge-and-strips are limited in the count rate they can achieve so that a partitioned system would be necessary for the largest formats. It was noted that for special applications the anode pattern can be shaped individually to match the format of the spectrum. Anodes can also be coded to give a direct binary readout of the photon location.

The same effect with additional centroiding possibilities is available with multi-wire anodes (MAMAs). Space qualified variants of the MAMA detector now exist and a large ($4 \cdot 10^6$ pixel) version is under development for a second generation Space Telescope instrument. Currently the MAMA pixels are large and laboratory experiments into the best attainable resolution are still in progress but smaller pixels may be possible.

A new exciting possibility of using a delay-line method for locating photons was presented at the meeting. This uses a pair of zigzag delay lines to read out the MCP charge cloud in the spectral direction and wedge-and-strip techniques in the orthogonal spatial direction where the resolution demanded is cruder. Developments will be watched with interest.

Finally television techniques of read-out are available in which the charge image is transferred directly or indirectly to a charge-coupled device (CCD). One scheme employing a photocathode on a solid substrate uses electromagnetic focussing to accelerate and transfer the photoelectrons to the CCD. A small version has been demonstrated in a rocket flight and study of extending the concept to the much larger *Lyman* format is under way. Design of a suitable permanent magnet assembly is in progress and it is believed that this can be done without a severe weight penalty. An alternative well-developed concept involves the use of a phosphor and fibre-optic boules to transfer the MCP output to the CCD. This solid and physically stable device is a development in regular use in ground-based astronomy and a space-qualification programme is in progress. Current pixel sizes give a 50% modulation at 20 line pairs per mm.

The third main topic at the workshop was the capability offered by direct CCDs. The key to the use of CCD detectors in the far and extreme ultraviolet lies in understanding and improving the electrical properties of the surface layer of back-illuminated CCDs. Normal CCDs have a dead layer on

the surface some 1000Å deep, controlled by the oxide that traps negative charges and grows on the surface in hours. Ideas to remove this include charging the backside by an ultraviolet flood, implanting a conducting layer of boron and using an electron donor layer (e.g. platinum) to fill the electron traps. In these ways CCDs with 20 to 30% quantum efficiencies near 1000Å can be made but the main problem is that the CCDs also are excellent detectors of optical photons. Various ideas to make CCDs optically-blind were proposed but this field obviously needs further work.

In a final general discussion, other concerns emerged. The radiation environment of the detectors and their associated electronics was discussed since both missions may operate above the Earth's radiation belts. What is known from previous missions suggests problems are not severe if the detectors are shut down during transit of the belts themselves but data on the effects on the ultraviolet spectrometer on *Voyager* during its passage through planetary radiation belts might be useful. Another general concern was whether some of the types of detectors presented might show fringing effects between the MCP pores and the pixel spacing: fourier transforms of flat-field calibration exposures should reveal any such micro-nonuniformities. Maximum count-rate limits are a concern in two areas. Firstly the time required for high signal-to-noise flat-field calibration frames is of order of hours and a stable detector therefore has the important advantage that it requires less calibration. Secondly high local count-rates will be needed to observe the bright stars studied by the *Copernicus* satellite and to link with the current astrophysical flux scale. A recurrent topic throughout the meeting was the relationship of pixel size to resolution and the need to understand exactly the specifications to be put on detector performance by the requirement to observe blended spectral features (e.g. weak deuterium in the wings of strong hydrogen lines).

The participants appeared to enjoy and benefit from the meeting and there were many comments on the fine conference centre Herstmonceux Castle provides.

Michael V Penston

THE LAURIE PROJECT MARK IV

At a time when the RGO is facing such a crisis in its history and as the number of its employees diminishes in accordance with the five year forward look, it is rather embarrassing to write of a section which has doubled its staff over the past three years.

Such is however my lot in bringing readers up to date with developments in the Laurie Project, which now boasts twenty-one employees and is slowly encroaching on further parts of the Castle. This is, of course, all in the good cause of archives and education, the work now in hand being very similar to that which has gone before, though at a higher rate of output.

Many will have seen our illustrated information pack for schools entitled *The History of Herstmonceux Castle*, published in October 1985. A second pack on *The Voyages of Discovery*, with a text by Heather Edwards (who now graces the general administration offices) and illustrations by Project staff has recently been printed. We hope that this will meet the acclaim which attended our Herstmonceux Castle pack. We are now working on a *History of the*

Royal Observatory, Greenwich and the staff paid a visit to the Old Royal Observatory to research the subject. However, the central *raison d'être* of the Project remains our work on the Archives. There are many twentieth century papers remaining which are still unlisted and although we devote five people to the task, the index to the vast collection of Airy papers is only 50% complete after almost four years work. We have completed the reshelving, wrapping, numbering and listing of the RGO's solar plate collection of some 23000 items. This year we have started similar work on the plates from the 13" Astrographic, the 26" refractor and the 30" reflector, which are all 16cm square and make a body of over 100,000 items for conservation and listing.

A new aspect of our remit is the employment of Project staff in the RGO Conservation Laboratory under the direction of Ian Maver. The problem which Ian has been trying to tackle since coming to RGO is the conservation of the huge number of folios in the Airy papers which, without assistance, he has not been able to undertake. The magic answer is of course the Laurie Project and so when the Manpower Services Commission suggested that we increase the number of people on the Project this was an obvious area in which they could be very gainfully employed. There are three part-time posts here and this means that not only is the Project making the papers available as Public Records but is also ensuring that there are papers to be made available. Another new endeavour for us and for RGO Archives generally is the creation of a sound archive which is being undertaken by the Project. We have purchased two good quality portable tape recorders and we are recording the reminiscences of some of our retired members of staff. Astronomy as practised at Greenwich and the early days at Herstmonceux are subjects where we shall lose our first hand record if we are not careful. The recordings will be transcribed and typed to a set format so that they can form a permanent part of our archival record and take a proper place in the history of the RGO.

The Observatory has recently provided the Project with an IBM Personal Computer which we use for wordprocessing in the typing of our listings and which we hope will soon be used for the creation of an indexing database. The PC has already made a difference to the speed and scope of our work. It has also meant that one of our staff, Sharren Kenward, who is confined to a wheelchair, is able to use this modern equipment conveniently, both adding to the material we produce and gaining useful personal experience for employment when she leaves RGO.

So the Laurie Project's work continues quietly in one corner of Herstmonceux Castle. What we want to stress is that the sponsorship of this Project has even enhanced the reputation of the RGO. Our Archives really do now offer a service to the scientific community second to none and the educational packs have created great interest amongst teachers from all over the country. This is something which would not have been possible in the present climate had it not been for the outside funding provided by the MSC. By the end of this year the total external funding of the Project will be in the region of £200,000. That an outside body such as the MSC has shown the confidence that this represents in the future of RGO's Archives is yet another reason why the collection should be maintained as an integral part of the organization that has and is still producing the records ... the Royal Greenwich Observatory.

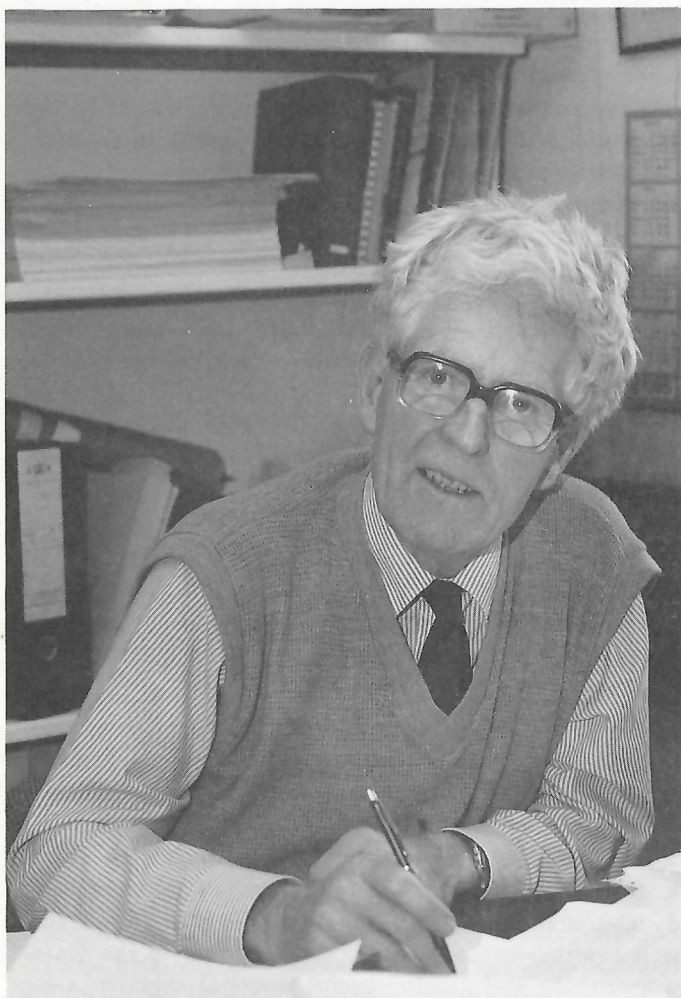
Adam Perkins

The Laurie Project, RGO Archives

STAFF CHANGES

There have been so many staff changes since the last issue of GEMINI that it would almost fill the Newsletter to print the usual photographs and pen portraits. I hope that the new staff will forgive a mere list of their names and that those who are leaving will excuse the very abbreviated account of their careers. I have also omitted to record the comings and goings of short-term staff, the 'cut-off' point being 2 years. I hope I have not forgotten anyone - if so I apologise!

Retirements



David Calvert

Andrew Murray joined the Royal Observatory in 1950 while it was still at Greenwich. His early work in the Meridian Department developed into an interest in photographic astrometry from which he built an international reputation as an expert in the field. Although he formally retired on 6 January 1986 Andrew is still to be seen at the RGO on most days where he plays a vital role among the small Hipparcos Project team. He also continues to serve on the management committee of the Carlsberg Automatic Meridian Circle.

Dennis Goring joined the RGO in August 1970 and retired on 19 March 1986. He was initially responsible for keeping the EQ telescopes at Herstmonceux in working order and later for the refurbishment of the Steavenson Telescope and its installation at the Sierra Nevada Observatory. He transferred to La Palma in 1983. As a member of a very small mechanical team he played an important role in getting the INT and JKT going and keeping them going. His efforts were always augmented by his constant willingness to provide a little entertainment.

Bill Nicholson retired on 11 May 1986, and in his honour we repeat a poem by Chas Parker "written on Pevensey Marshes whilst waiting for a car windscreen to be fixed":

*There's a little brick-built clubhouse to the south of Herstmonceux,
There's a man who helped to build it years ago,
There's a GALAXY of friends here, just to bid him fond adieu,
While the rest of us left here are filled with woe.*

*Now the Cape Plates that he's measured number thousands,
I am told,
And from hard work he is never one who hides.
His astrometric talents are a wonder to behold.
In his spare time he plays croquet, bridge and glides!*

*Yes, there's a chap who's known for Staff Side work, of which he's never tired,
And without him RGO won't be the same.
For although sometimes his language leaves a lot to be desired,
We'll all miss him - Bill Nicholson's his name.*

When **John Pharoah** came to the RGO in 1960 he was one of the first draughtsmen employed here. He retired on 5 August 1986 after 26 years at the RGO, where he has made his mark in many aspects of the drawing office work. He has also contributed a great deal to the RGO Club having been the first bar secretary and at other times club and trading secretary.

Chub Barnard retired on 5 Sept 1986 after more than 39 years working at Herstmonceux Castle. He was first involved in the building of the Equatorial Group in 1947, later he became a Night Watchman, then a cleaner and finally a Messenger.

Alf Heath retired on October 10 1986. He joined RGO as Safety Officer from Rutherford Laboratory in 1978 later combining this with the job of Head of Site Services. He has spent the last two years on La Palma where he has been as diligent and firm on safety matters as he was at Herstmonceux. His friendly straightforward manner won him many friends among the local people - an important step in integrating the Observatory into the local community.

Jim McConnell retired on 16 December 1986. Jim joined the RGO in 1979 after serving many years in the East Sussex and Sussex Police Forces. He spent most of his time here in the stores and purchasing section.

Ken Long took early retirement on 30 March after just 7 days short of 30 years service at the RGO working on electronic and electrical maintenance. Since 1978 he has been Head of the Electrical Section of the site services group. He has been a very active member of the club having been involved in the building of the Clubhouse, and was particularly involved in organising (and winning) in-house table tennis tournaments.

Sarah Griffin took early retirement at the end of March, having worked in the Time department ever since she joined the RGO in September 1969. She too has been an active club member participating in a wide variety of sports and has taken well disguised parts (in fur and feathers) in RGO pantomimes. Her retirement will allow her to spend more time with her baby, Helen, born last May.

Resignations

Brian Slaughter resigned on 10 January 1986.

Ann Elliott resigned on 14 February 1986.

Barbara Herbert resigned on 2 May 1986.

Tony Jorden left on 31 May 1986 to work at Oxford Instruments. He spent 10 years working in Instrument Science at RGO taking particular responsibility for the IPCS from its early days to its latest development, in collaboration with researchers at UCL, for use on the WHT.

Philip Taylor left at the end of July 1986 to teach Software Engineering at Brighton College of Technology.

Ralph Powell left at the end of September 1986.

Carl West left on 31 October 1986 after 18 years at the RGO. During this time he contributed greatly as a draughtsman to the whole spectrum of instrumentation including spectrographs, telescope work and the CCD and IPCS detector systems.

Simon Lawrence left the RGO on 24 October 1986 after 6 years here to work for the Health Authority in Lewes. His time at RGO was divided between stores section, personnel and looking after the administrative side of the Exhibition and Conference Centre.

Jim Lester left on 2 January 1987.

Other Staff News

Exchange of Division Heads

As from 2 April 1987 **Jasper Wall** became Head of La Palma Operations Division and took up residence on La Palma as Officer-in-Charge. **Neil Parker** became Head of the Technology Support Group on La Palma. At the same time **Paul Murdin** became Head of the Astronomy Support and Research (ASR - previously A & A) Division at Herstmonceux. After a period of change-over, **Keith Tritton** will return to the UK and become Head of the La Palma Unit at Herstmonceux.

In January and March 1987 respectively, **William Lupton** and **Max Pettini** transferred to the Anglo-Australian Observatory for periods of 2-3 years.

Neill Reid has gone to Caltech.

Bill Sparks is spending 12 months at the Space Sciences Institute in Baltimore, Maryland.

We are all pleased to welcome back **Ed Zuiderwijk**. Ed has replaced **Klaas de Boer** as the astronomer resident at Herstmonceux to represent Dutch interests in the Anglo-Dutch collaboration on La Palma.

Guy Rixon who is working on his Sussex University D Phil is to be based at RGO for three years.

New Staff

(I make no apologies for the abbreviations; they will either mean something or they won't!)

John Mills	6.1.86	Electronics, La Palma
Andrew Inchley	13.1.86	PTO4 La Palma
Chris Benn	27.1.86	HSA ASR
Bill Sparks	1.4.86	SRA ASR
Hazel Head	2.4.86	telephonist/receptionist
Ann Botha	7.4.86	P/T Typist

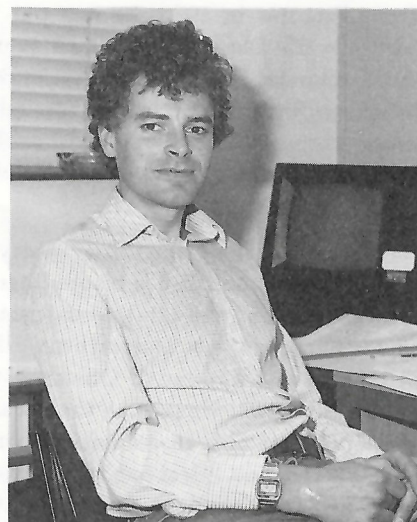


Richard Worth

John Mills

Gary Rae	14.4.86	PTO Eng. w'shop
Keith Herbert	6.5.86	PTO La Palma
Andrew Stubbs	28.5.86	PTO La Palma
Steve Murphy	28.5.86	PTO La Palma
John MacLean	9.6.86	PTO Electronics
Jonathan Burch	16.6.86	SO La Palma Software
Richard Abraham	23.6.86	HSA La Palma Software
Chris Mayer	3.7.86	HSA La Palma Software
Claire Hucklesby	7.7.86	CO Finance
Alan Popplestone	14.7.86	SPTO Facilities
Graham Newton	28.7.86	HPTO Inst. Science
Cynthia White	18.8.86	P/T Typist
Ed McCann	1.9.86	Schoolteacher La Palma
Steve Unger	1.10.86	SRA ASR
Nicholas Fuller	9.12.86	SRA ASR
Elias Brinks	1.1.87	SRA ASR
Ken Duffill	5.1.87	HSA La Palma Software
NK Fernyhough	5.1.87	PTO Eng. w'shop
Frank Gribbin	19.1.87	HSA La Palma Software
James Dick	29.1.87	SSO Inst. Science
Marion Fisher*	1.2.87	HSA La Palma
Tony Farrington	23.2.87	Electronics, La Palma
Charles Jenkins*	1.3.87	HSA ASR
Steve Percival	2.3.87	HSA La Palma
Peter Gray	30.3.87	HSA La Palma
Paul Martin	21.4.87	PTO La Palma

* previously temporary, now permanent staff members



Richard Worth

Chris Benn

Obituaries

We are sorry to have to record the deaths of the following past members of staff:

Mr H W Newton who was for many years in charge of solar work at Greenwich and at Herstmonceux died on 12 December 1985. He first joined the staff in 1910, when Christie was Astronomer Royal and Eddington was Chief Assistant, and he retired in May 1955. In 1946, Mr Newton was awarded the Jackson-Gwilt Medal of the Royal Astronomical Society for his work on the Sun, notably on the relation between solar flares and magnetic storms.

Jack Pike who was a forester and gardener at the RGO from 1949 until his retirement in 1970 at the age of 78, died last year aged 94.

Mick Dermody who served as workshop foreman from 1956 until his retirement in 1977 died on 25 September 1986. He was involved in the mechanical commissioning of telescopes in Egypt, Spain and South Africa and with the mechanical care of the telescopes at Herstmonceux. He was awarded the BEM in 1976.

George Harding

George Harding died suddenly on 1986 April 28 whilst on holiday in the Canary Islands.

George began his remarkable astronomical career when he joined the NAO shortly before the outbreak of the Second World War. He returned to this department after wartime service in the army where he became a captain in the Royal Signals. Although these early activities may seem far removed from planning an astrophysical observatory, they provided him with some of the very broad experience which much later was so invaluable to the RGO.

In 1956, George transferred from the NAO to the Astrometry Department. He rapidly became adept at setting up and adjusting telescopes in the Equatorial Group at Herstmonceux. Then followed a three-year period as "Cape Observer" at the Radcliffe Observatory, Pretoria. Measuring the spectra of stars in ω Centauri which he obtained using the Radcliffe 74-inch telescope, George was the first astronomer to detect the rotation of a globular cluster.

On his return from Pretoria in 1963, he was put in charge of the Astronomer Royal's Department which then was engaged mainly in photometry and radial velocity work. Although he had had no formal training in astrophysics, he had a good overall grasp of the astronomical problems being studied and his appreciation of instrumental effects was invaluable.

In the late sixties, morale at the Cape Observatory was very low because of uncertainty about SRC's future interest there. In relatively rapid succession, the Chief Assistant and HM Astronomer had resigned. It was under these difficult circumstances that George was appointed Officer-in-Charge of the Cape Observatory in 1969. He rose to the occasion magnificently with his quiet but firm leadership. After a period of continuing uncertainty, SRC decided to maintain an involvement in South Africa by participation in SAAO. George took a major part in the setting up of the new observatory and then as Deputy Director of the new SAAO.

On coming back to Herstmonceux in 1975, he spent the remainder of his career as Project Scientist for the Northern Hemisphere Observatory (now called the Roque de los Muchachos Observatory) on La Palma. As this part of his work is very well-known to most readers, it will not be mentioned in detail. Although George officially retired from the RGO in 1980, he continued his involvement with La Palma until shortly before his death by preparing observing manuals and giving general advice.

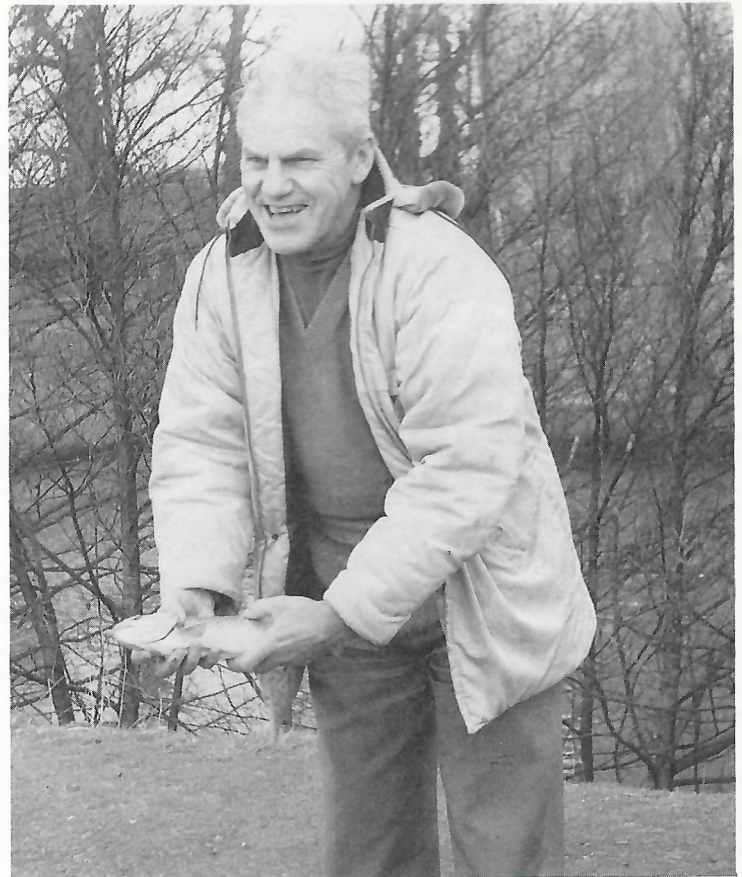
In his leisure hours, George participated fully in social and sporting activities with his colleagues. In his younger days, he was a keen and able cricketer. Wherever he was, George displayed a good sense of humour which was never malicious. He will be remembered with affection by all those who knew him.

We extend our deepest sympathy to his wife Gladys and the rest of his family.

JBA

Sir Richard Woolley

Richard van der Riet Woolley, the last Astronomer Royal to be Director of the Royal Greenwich Observatory, died on Christmas Eve at the age of 80.



David Calvert

He was born at Weymouth and was educated at Cape Town University and subsequently at Gonville and Caius College, Cambridge, where he took the mathematical tripos in 1928. After working for a year under Sir Arthur Eddington, he became a Commonwealth Fund Fellow at the Mount Wil-

son Observatory. From 1931 to 1933 he was Isaac Newton Student at Cambridge, before becoming Chief Assistant at the Royal Observatory, Greenwich under Sir Harold Spencer Jones. While at Greenwich he took particular interest in the solar work and also in observations of double stars. In 1937 he returned to Cambridge as John Couch Adams Astronomer where he remained for two years until being appointed Director of the Commonwealth Solar Observatory, Canberra in 1939.

When the Australian National University was founded in 1946 the Commonwealth Solar Observatory was incorporated into the University as the Mount Stromlo Observatory. Woolley actively promoted the arrangement and became the first professor of astronomy at the ANU. He soon expanded the Observatory's work into stellar astronomy and arranged for the purchase of the Mount Stromlo 74-inch reflector to carry out these programmes. During his 17 years in Australia he developed the Mt Stromlo Observatory into one of the leading observatories in the world.

In 1956, Woolley succeeded Spencer Jones as Astronomer Royal. His first task was to install and commission all the major instruments which had been moved from Greenwich, and by 1958 there were many thriving programmes of observations being carried out at Herstmonceux. Under his influence, the main researches were in the fields of stellar kinematics and the structure of star clusters and of the Galaxy. He inspired programmes of observations of proper motions, radial velocities and photometry at Herstmonceux and at the Cape and Radcliffe Observatories with which he had instituted close collaboration by seconding staff from RGO for three year tours of duty.

Work on the delayed Isaac Newton Telescope was resumed in 1958 and Woolley was anxious that some astronomers in the UK should get experience with large telescopes. To this end he took members of his staff with him on observing trips to Mount Wilson.

He took a keen interest in astronomical education. In his first year at Herstmonceux he instituted the annual vacation courses for undergraduates during the summer vacations. Many of today's leading British astronomers were introduced to the subject through these courses. He was also instrumental in the creation of the Astronomy Centre at the University of Sussex and its close collaboration with RGO through M Sc courses and supervision of D Phil students.

Another feature of the annual calendar at RGO which started during Woolley's time is the Herstmonceux Conference to which many astronomers from the UK university departments and from abroad come each year.

On his retirement from Herstmonceux at the end of 1971, until 1976, Woolley became the first Director of the South African Astronomical Observatory which combined the instruments of the old Royal Observatory at the Cape and the Radcliffe Observatory at Pretoria on the new site at Sutherland.

He was President of the Royal Astronomical Society from 1963 to 1965 and Vice-President of the International Astronomical Union from 1952 to 1958.

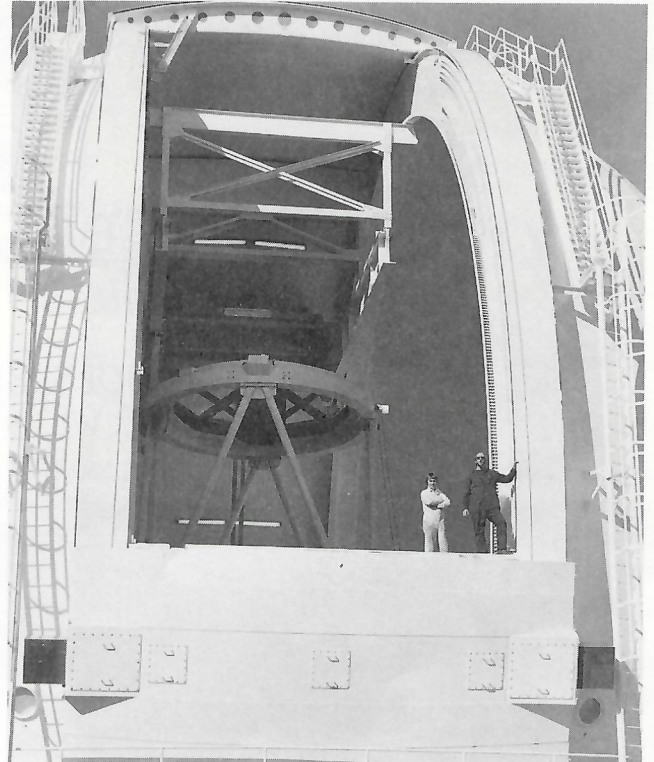
He was an accomplished pianist and a keen cricketer. He was also an enthusiastic country dancer and during all his time at Herstmonceux he ran a weekly group for staff, visitors and local inhabitants.

A man of considerable dignity, although on occasions outspoken and apparently hasty in his judgements, he was highly respected by those who worked closely with him.

In 1976 he finally retired to his house in Sussex, where he stayed until 1979 when his first wife Gwyneth died. He then married Patricia Marples who was known to many astronomers at home and abroad as the canteen manageress at Herstmonceux Castle for more than 20 years. They returned to South Africa where Patricia died in 1985. He is survived by his third wife Sheila.

(CAM, DHPJ)

WILLIAM HERSCHEL TELESCOPE



David Calvert

The last few weeks have seen the final preparations for "First Light" on the William Herschel Telescope on 1 June: the mirror will have been aluminised, installed and aligned in the telescope, in parallel with hardware and software control tests being carried out.

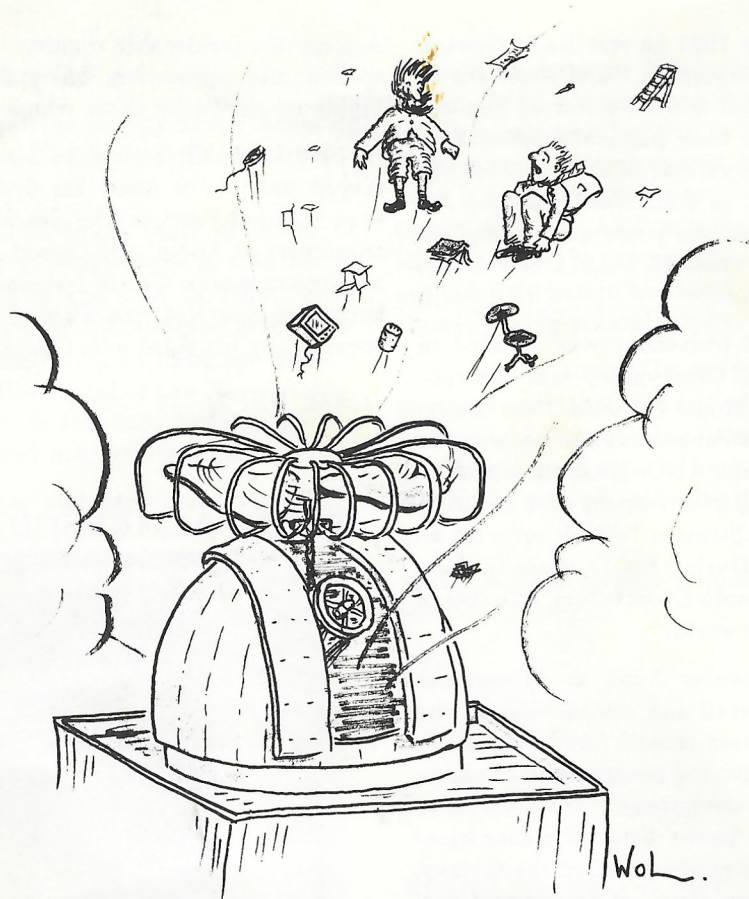
STOP(-WATCH) PRESS:

For one 10^h:6 clear and trouble-free night in March, in which the CCD was used on the Spectrograph to obtain 52 exposures on 20 different stars, the time budget was distributed as follows:

star exposure	61%
arc exposure	1%
read and store data	21%
change equipment configuration	3%
slew and acquire stars	14%

A considerable fraction of the time for data handling would have been saved if the IPCS had been used.

Derek Jones



'O.K. IT DOES BLOW THE CLOUD AWAY, BUT WE STILL CAN'T USE IT'



The note on this Lego Castle set which Alec received as a Christmas gift from staff, read

"An executive toy? Hoping it will enable you to provide us in Cambridge with the type of building to which we are accustomed. Note that this castle comes with its own defenders!"

EDITORIAL

We apologise for the long gap between this and previous issues of GEMINI. As you see from the size of this issue, the delay was not for lack of material, but has been entirely because of pressure of other work.

I look forward to having your contributions for GEMINI No. 17, which I hope will come out in about 3-months time: if these are already in T_EX format I will be even more delighted. I want to hear from more La Palma users. Please write to GEMINI with any items you think would be of interest to other users - be they exciting astronomical results, or suggestions for improvement to the facilities (you can at least try), or even details of an especially good restaurant you have discovered on the way there.

Margaret Penston