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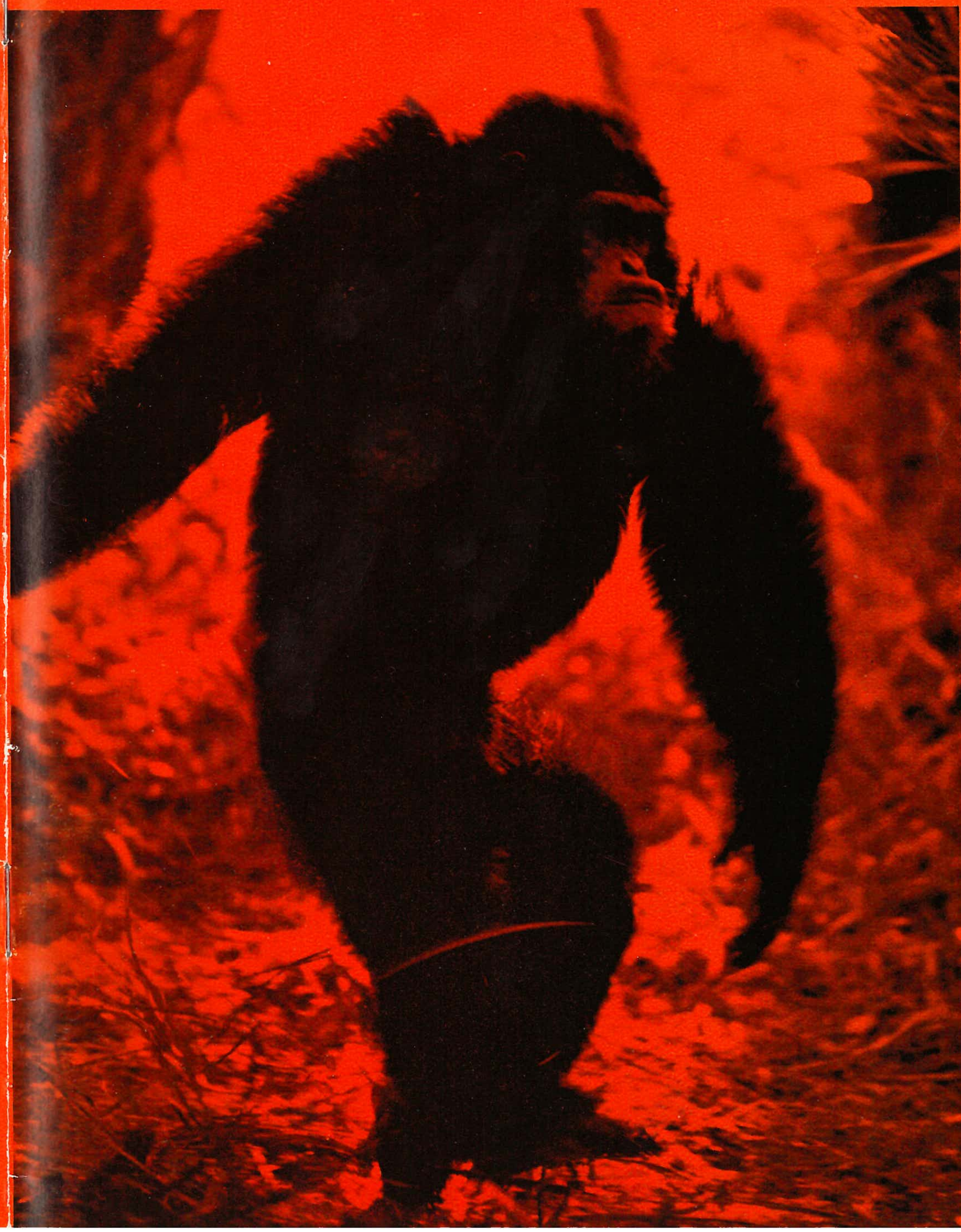

'All the world's
a stage . . . .

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QUEST

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All the world's a stage . . .

Boss chimp acting the part of fearless protector as he rushes for a free feed of bananas at an observation area in Gombe National Park, Tanzania. story on page nine.

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profile

A. H. Spurway, B.Sc.

Rutherford High Energy Laboratory

Science, politics, and the upkeep of a XVIIth century farmhouse home (not in that order) are probably the most absorbing aspects in the life of Alec Spurway, Chairman of the 'staff side' of the departmental Whitley Council and of the SRC branch of the IPCS.

A keen student of local government and union affairs, Alec Spurway became the first-ever Labour Councillor on the Wantage UDC in 1965, and in the election in the following year, achieved the distinction of being the *ONLY* labour member on the Council. Typically, he enjoyed his lone status and influenced many debates by the force of his argument. At this time he was elected to the County Council for Abingdon West and held the seat for three years, until the Tory local elections landslide in 1968.

He is the Chairman of the SRC branch of the IPCS and also of the staff side of the departmental Whitley Council, which deals with all matters relating to staff conditions in the regular debates with the official side of SRC.

Following the publication of the Trend Report in 1965, which recommended the change-over from NIRNS to SRC, Spurway campaigned for the retention of the AEA pension scheme which permitted its members to move about within the industry, without losing their pension benefits. The SRC scheme did not contain this flexibility and Spurway felt strongly that a radical government ought not to seek to deprive the staff of such an important concession.

The campaign had a successful outcome and in the Commons on March 15, 1965, Anthony Crosland accepted the amendment put down by Lord Bridges during the Report Stage of the Science and Technology Bill. Crosland admitted that the Government had changed its mind about opposing the amendment after listening to many representations from the IPCS. '. . . I make no apology for this . . .; we were simply convinced by the arguments put forward.'

Born in 1928, Alec Spurway was educated at Hendon County Grammar School in North-West London, and at the University College of Hull, where he spent three of the immediately post war years before he was inducted into the RAF for two years of National Service. This was the era of the squatter, so Spurway and three colleagues who worked in an 'H' shaped transmitter building on a hill overlooking the airfield at Benson, used to sleep in splendid isolation in the four corners of the building to ward off invasion.

He left the RAF in 1951 and joined Elliott Bros. Ltd. at Borehamwood, Herts, left after two years to join AEA at Harwell, and became involved in a series of measurement of thermo-neutron cross sections. He also became interested in accelerators, and after three years at Harwell, transferred to the Rutherford Lab. to work on the design study and the measurement of magnetic fields for Nimrod.

Nimrod completed, Spurway moved into new work in association with Dr. P. F. Smith, to study the production of magnetic fields by superconductors at low temperatures. The group is now leading the field in the use of filamentary superconductors which could radically alter the present concepts of large accelerator design, and have far-reaching effects on the design of power generating plant.

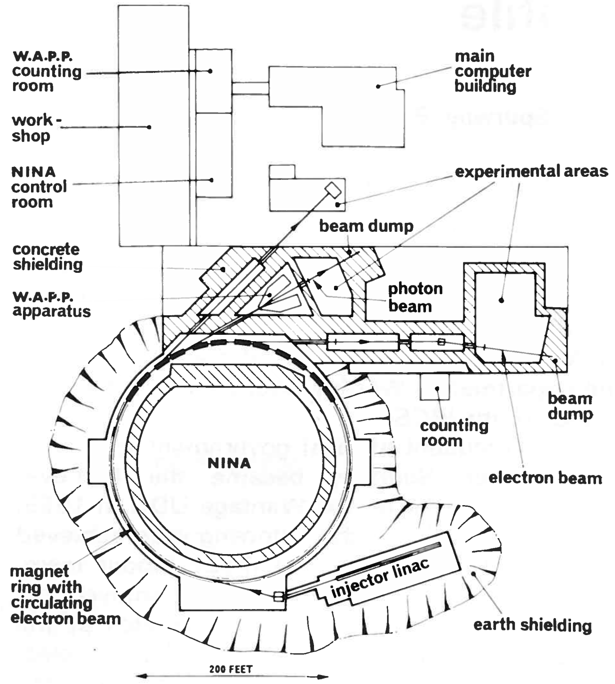
With local government and union affairs absorbing so much of his spare time it is incredible that he should even consider the purchase of the old farmhouse in Wantage, but it was reasonably priced and offered much scope for conversion to accommodate his family of five children. It was in a poor state of repair, but with hard work and gallons of woodworm killer, the house has been transformed into a comfortable home, full of character and enviable space.

particle physics . . . the ultimate structure of matter

an introduction to
high energy physics
for non-scientists

R. E. Rand

part 2 a typical experiment



recapitulation

The first part of this article explained the basic concepts involved in high energy physics and outlined the present state of our knowledge of the ultimate structure of matter. It also explained many terms which will be used in this second part. The way in which such knowledge is obtained and expanded will now be illustrated by a description of the organization and performance of a typical experiment at Daresbury Nuclear Physics Laboratory. As previously explained, such experiments, which investigate the interactions of fundamental particles, require an incident beam of high energy particles from an accelerator in order that the finer details of the interactions may be observed.

the laboratory

A typical layout for a medium size high energy accelerator laboratory is illustrated by the schematic plan of DNPL (above). Note that both the accelerator (NINA) and the experiments must be controlled remotely because of the high radiation levels in the vicinity of the intense particle beams. To protect personnel from this radiation and to shield the experiments from each other, heavy concrete blocks, several feet thick are used. The blocks may be moved about by overhead crane whenever it is desired to rearrange the experimental area.

NINA itself is a synchrotron which accelerates electrons to energies of up to 5 GeV or 5 thousand million electron volts. An electron volt is defined in the following manner. Suppose an electron could be released at the negative terminal of a 1 volt battery. It would be attracted to the positive terminal and accelerated towards it thus gaining energy. By the time it had reached the positive terminal, it would have acquired an energy of 1 electron volt.

A synchrotron consists basically of a ring of electro-magnets containing a doughnut shaped vacuum chamber in which electrons may circulate in a stable orbit, the path of the electrons being bent into a circle by the magnetic fields. A bunch of electrons is injected into the ring by means of a linear accelerator (Linac) and as soon as the beam is in a stable orbit, the electrons are 'kicked' up to a high energy by oscillating electric fields at five points around the ring. This process takes about one hundredth of a second during which the electrons perform about 140,000 revolutions. In order to hold the radius of the orbit constant, the magnetic field must be increased with the energy. When the electrons reach their maximum energy they are ejected from the ring, the magnetic field drops and a new bunch is injected. The process is repeated about fifty times a second.

The electrons can either be ejected directly by means of a pulsed electric deflector, or a secondary beam of photons can be produced by allowing the electrons to hit a tungsten wire inside the vacuum chamber.

The beams may be produced at any of three different points around the ring and 'transported' to the various experiments. At the end of each beam line the particles are 'dumped' into a shielded block of concrete where the energy is dissipated as heat. The intensity of the beams is also monitored at the beam dumps.

At present up to three experiments may be performed simultaneously on different beam lines. Each experiment has a target, often of liquid hydrogen, in its beam and apparatus to detect and measure the properties of the particles produced or scattered in the target. The passage of the particles is detected by scintillation and other counters as described in the previous article. Electrical signals from these counters are fed via cables to the counting rooms where they are analysed and the information stored on magnetic tapes or fed to the main laboratory computer by means of a small 'on-line' computer. The position of the apparatus and counting room for the wide angle pair production (WAPP) experiment, described below, are indicated in the heading figure.

The accelerator is run on a 24 hour basis to increase its efficiency and minimise running costs. This also ensures a maximum experimental capacity for the laboratory.

life history of an experiment

Experiments are performed usually to confirm or disprove the predictions of some theory concerning the behaviour or existence of particles. Often the results are completely unexpected and lead to new theories and predictions. A typical experiment may originate in discussions by a group of physicists who wish to investigate a particular problem. While formulating their ideas, they will have further discussions with other physicists both experimental and theoretical. In order to perform an experiment successfully and efficiently a group must consist of from say six to fifteen physicists with a similar number of technical personnel. The backing of laboratory services (electrical, mechanical, plumbing, etc.) is essential. In a given laboratory up to ten groups may be in some stage of performing an experiment at any one time.

The physicists must decide the best way in which to perform the experiment. They make a rough design of the apparatus from which a cost estimate can be produced, and estimates of services required including computing time must be considered. Usually the cost of the apparatus alone will be of the order of £200,000, although much of it may be re-used in subsequent experiments. The experiment may take up to three years from original idea to final results. The amount of time required on the accelerator is of utmost importance and must be carefully estimated. This usually works out at about 200–400 hours, the total cost of running the machine being of the order of £600 per hour. Competition between groups for accelerator time is often intense.

Having collected and calculated all the relevant information, the group of physicists must write a 'proposal' which is presented to a selection committee consisting of eminent high energy physicists.

The theoretical case for the experiment and the feasibility of the method must be publicly argued in front of this committee who then decide whether or not to allocate the necessary funds and make available the laboratory's facilities.

Once approval is obtained, the detailed design of the apparatus by the laboratory's engineers can begin. They decide which parts can be made in the laboratory's own workshops and which by outside firms. The Services Group arranges to install the concrete shielding for the experiment and to lay the necessary cables and hoses, etc. The experimental officers and technicians, attached to the Experimental Group, design and assemble the necessary counters and electronics.

Once the apparatus is set up in the experimental area and connected to the electronics in the counting room, the physicists can start to test and calibrate the equipment using a beam from the accelerator. This is initially done on a 'parasite' basis by which the group which is setting up may take only a small fraction of the bunches of particles from the accelerator, while some other group (the 'main user') which has finished calibrating uses the majority of the bunches to obtain its data. The latter group have control over the operating conditions of the accelerator. The setting-up phase of an experiment may take up to half the total running time. Once the apparatus is calibrated and fully tested, the group becomes the main user and starts to obtain the necessary data. This is achieved by counting the number of particles accepted and selected by the apparatus under specified conditions. The rate at which the particles arrive may vary from several a second to a few an hour. Information on the types of particles and their energies and directions is stored on magnetic tape or in a computer.

The 'raw' data thus obtained is further analysed by computer in order to extract the required information and compare the results with theoretical predictions. Finally, the results with the conclusions of the physicists, are published in an internationally read physics journal. These last two stages may take up to a year or more before the final article appears.

an experiment at DNPL – wide angle pair production

The first resident experimental group at Daresbury is now in the final stages of an experiment which tests the validity of quantum electro-dynamics (or QED), the theory of electrical forces. In this experiment a high energy photon beam from NINA passes through a liquid hydrogen target. In the presence of the protons (hydrogen nuclei) in the target, some of these photons form electron-positron pairs. QED theory predicts just how many such pairs should be formed within a certain momentum (energy) band and angular range for a given number of incident photons. The apparatus shown in fig. 2 is set up to observe the electron-positron pairs and check whether the number produced agrees with the theoretical prediction or not.

The photon beam from NINA passes through the hydrogen target and along the beam pipe. Its intensity is monitored at a beam dump located about 50 feet beyond the apparatus as shown in the heading figure.

The apparatus itself consists of two identical, but mirror image, platforms on which are mounted various magnets and particle counters. Each arm is referred to as a magnetic spectrometer, since it is capable of measuring and selecting the momenta of electrically charged particles which enter it. In order to simplify the theoretical interpretation of the results, the two spectrometers are set at the same angle with respect to the incident beam. In the target, particles are produced travelling in all directions. Each spectrometer can only observe those particles which happen to be produced within its angular acceptance.

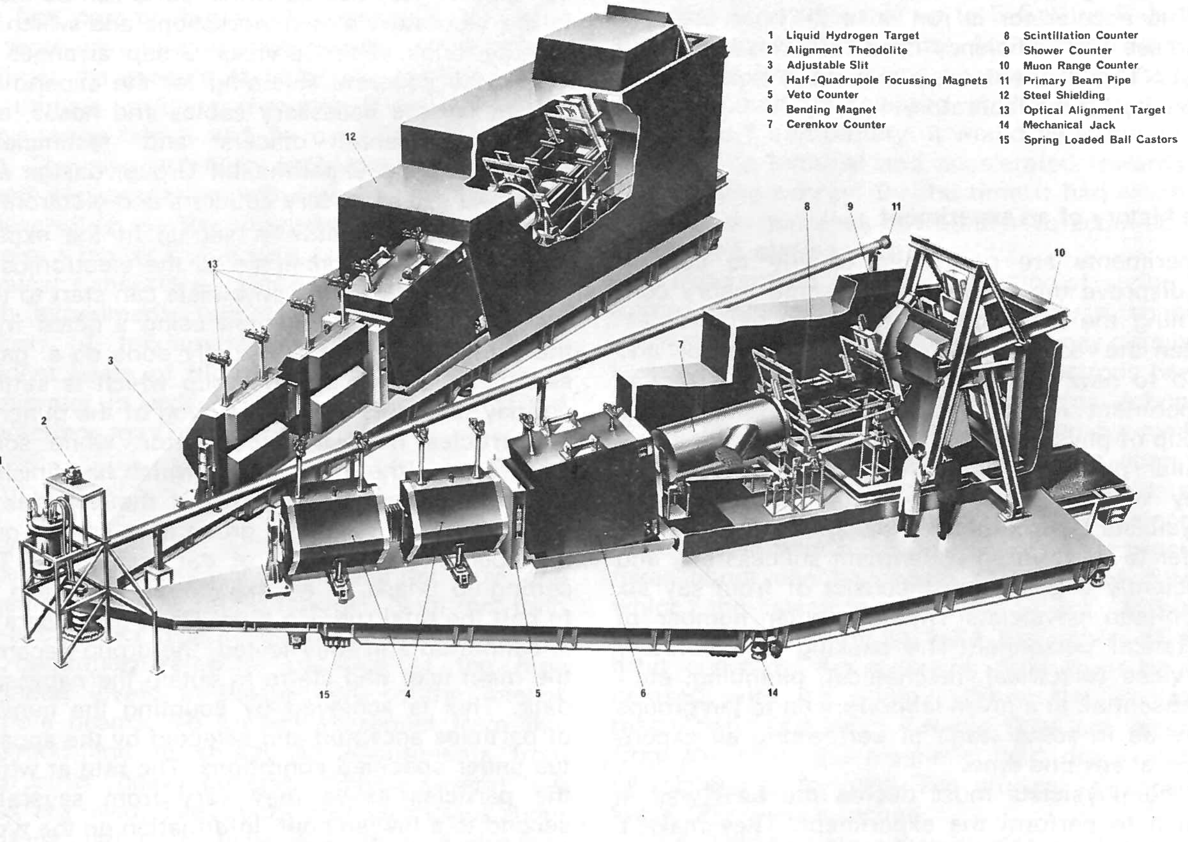


Fig. 2. Daresbury Group experiment to study the photo-production of electron and muon pairs.

A pair of particles (one positive, one negative), which originate in a single interaction in the target and enter the spectrometers is identified by electrical pulses which are produced simultaneously in the counters on each arm.

The chief difficulty of this experiment is that charged pions are produced in the target as well as electrons. In fact the latter may be outnumbered by up to 1000 to one. The counters must therefore be capable of distinguishing with very high efficiency between pions and electrons.

The principle of the liquid hydrogen target is shown in fig. 3. It is basically a large vacuum flask. The target itself consists of a plastic cell suspended below a reservoir of liquid hydrogen. Tubes from a cylinder of hydrogen gas pass through the reservoir so that the hydrogen condenses as a liquid in the target cell. Normally the photon beam passes through the target cell, but in order to observe the number of unwanted 'background' particles produced by photons in the walls of the cell itself, the whole device can be raised so that the beam passes through an evacuated dummy cell.

Fig. 4 illustrates the way in which electrically charged particles from the target are classified according to their momenta by a spectrometer. When a particle enters the region of uniform magnetic field in the 'bending' magnet it experiences a force perpendicular to its direction of motion. Its trajectory inside the magnet thus becomes an arc of a circle the radius of which depends on the particle's momentum. The paths of low momentum particles are deviated more than those of high momentum particles so that the momentum of any particular particle which traverses the spectrometer may be determined by observing which scintillation counter of the array is triggered. The actual spectrometer is more complicated than this having also quadrupole magnets, which act like lenses and focus the particles onto the scintillation counters.

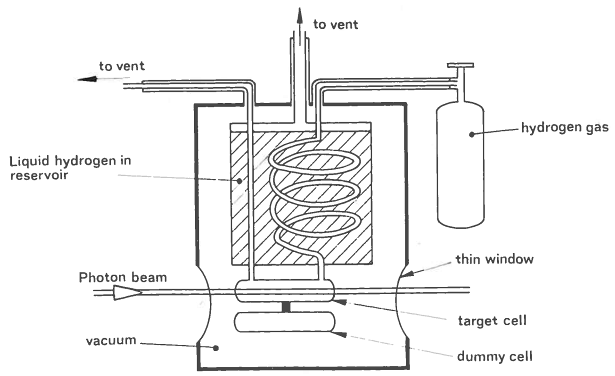


Fig. 3. Liquid hydrogen target.

Particles are identified and distinguished by three different devices. The first of these is a Cerenkov counter which consists of a large cylinder of Freon gas. If a particle passes through a transparent substance, such as the gas, at a velocity which is greater than the velocity of light in that substance, it produces a flash of light in much the same way as an aeroplane produces a sonic boom when it travels faster than the velocity of sound. This flash of light may be detected by a photo-multiplier in order to record the passage of the particle. Moreover the counter is only sensitive to particles travelling faster than the velocity of light in the gas, so that high energy electrons, which come in this category, are detected, while pions, which, being heavier, travel more slowly, are not.

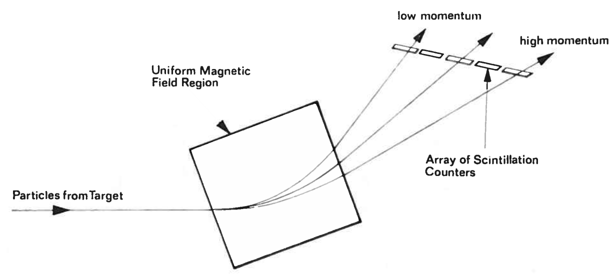


Fig. 4. Simple magnetic spectrometer.

The second device used to distinguish between electrons and pions is a shower counter. This consists of alternate layers of lead and perspex as shown in fig. 5. An electron which enters the first lead sheet produces a photon (by the bremsstrahlung process) which may then enter the second sheet of lead and produce an electron-positron pair. Each of these particles and the original electron may produce further photons in subsequent lead sheets, thus leading to the production of more electrons and positrons. This process is referred to as an electro-magnetic shower. The particles in the shower pass through the sheets of perspex where the electrons and positrons produce Cerenkov light which is detected by photomultipliers. A pion passing through the counter does not produce a shower and thus comparatively little light is produced in the perspex. Hence electrons are preferentially detected.

The last discriminating device in each spectrometer is a range counter which is used to identify muons. The latter are able to penetrate much greater thicknesses of material than electrons or pions, so that by placing a scintilaltion counter behind a block of iron of sufficient thickness to absorb other particles, muons may be observed.

The apparatus is therefore also capable of detecting and distinguishing pairs of muons formed in the target. The importance of this facility is to determine whether or not the theory of QED predicts the behaviour of muons as successfully as that of electrons.

The various counters contained in the spectrometers have now been described. The electrical signals from these counters are fed via cables to the counting room where, by observing that appropriate groups of counters fire simultaneously, one records the production of a pair of electrons, pions or muons.

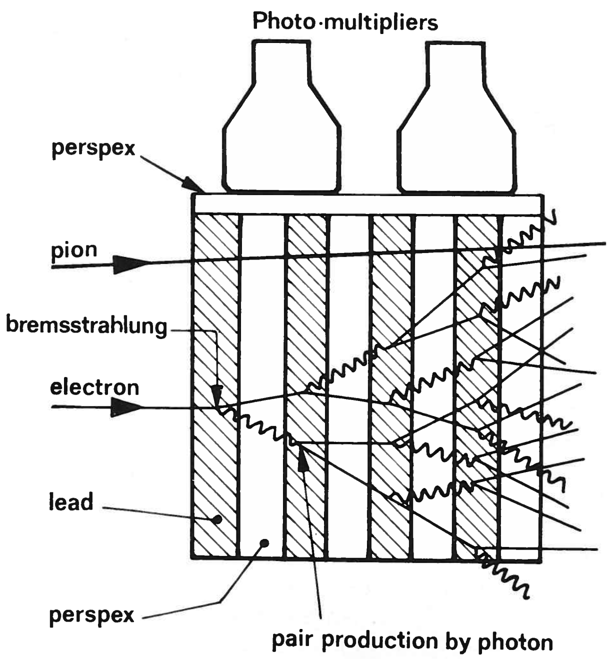


Fig. 5. Shower counter.

other types of experiment

The experiment described above comes under the broad heading of photo-production in which particles are produced by an incident photon beam. Other types of experiment generally done at electron accelerators are electro-production and electron scattering. At proton accelerators such as NIMROD, the main particle beams available are of protons and pions so that the emphasis is on studying strong interactions rather than electro-magnetic processes. At both types of accelerator, other secondary beams of 'strange' particles such as kaons are available so that the properties of these particles may also be studied. Detecting apparatus is divided into two main types, counters and track chambers. The apparatus described above belongs to the former class. The latter consists of bubble chambers and spark chambers in which the passage of particles is observed by the trails of bubbles or sparks, they leave. These are analogous to the vapour trails left by aeroplanes. The photograph accompanying the first part of this article is of tracks in a bubble chamber. It contains many examples of particle scattering and of production of secondary particles.

conclusion

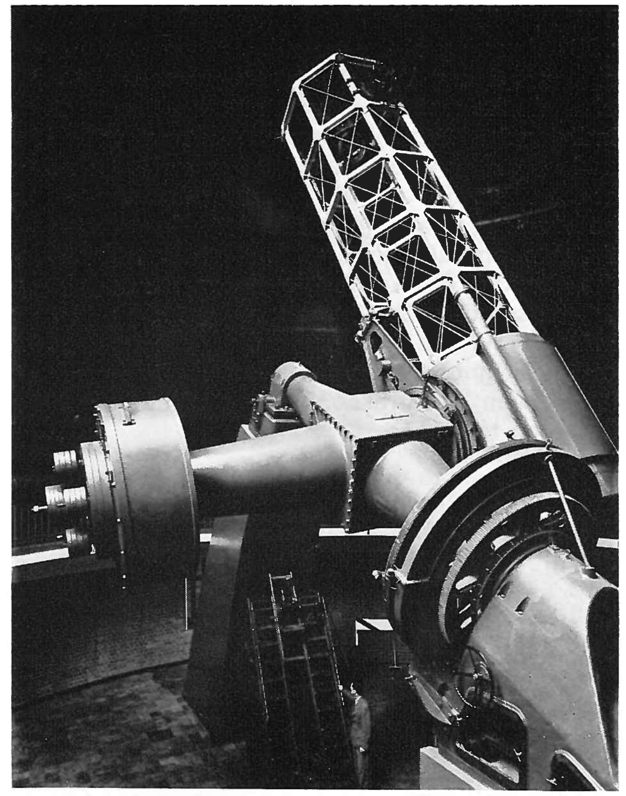
I hope that this article has at least partially clarified for the reader some of the mysteries of high energy physics research. The purpose of this research is to observe and correlate phenomena so that they can be described by just a few basic postulates and theories. Such theories can then be used to predict new phenomena and possibly to devise practical applications. For the physicist it is an exciting subject not only because his own experiment might form some essential part of the jigsaw puzzle of particle structure, but also because he can watch the subject grow in the knowledge that a major breakthrough is possible at any moment. The probability of this occurring increases as more facts are accumulated and it is now evident that some vital problems will only be resolved by doing experiments at higher energies than those now available. Hence new and larger accelerators will be required.

Thus it would be a tragedy if the proposed European 300 GeV Accelerator were not built merely because the benefits to man were not immediately obvious. Happily it seems most probable that the project will go ahead in spite of the non-participation of the UK. It is hoped that this unfortunate situation will not permanently damage the future of high energy physics in Britain.

the busiest telescope in the world

a brief account of the work of the Radcliffe Observatory, Pretoria

A. D. Thackeray



The Radcliffe Observatory was moved from Oxford to a site on the outskirts of Pretoria in the 1930's as a result of a far-sighted decision by the Radcliffe Trustees that the interests of British astronomy would be well served by setting up a modern large reflector in an excellent climate in the southern hemisphere. Although the Trust funds could scarcely support a staff of three full-time astronomers and a little additional labour, it was felt that the project was of sufficient importance that other support would be forthcoming. The Observatory is at present supported mainly by SRC through a seven-year agreement with the Radcliffe Trustees.

Due to the war and other factors, the 74-inch reflector did not go into operation until 1948 and even then another two-and-a-half years passed before the two prism Cassegrain spectrograph was received; this instrument has occupied some 70 per cent of the telescope time ever since. The problem of measuring Doppler shifts of southern stars had been almost completely neglected for about twenty-five years and essentially nothing was known about the motions of southern objects fainter than $5\frac{1}{2}$ magnitude. Since 1951 the Radcliffe spectrograph has been applied with great success to thousands of objects extending to 10 magnitudes (i.e. 10,000 times) fainter than the old limit.

The main Radcliffe programmes have been concerned with

(1) the dynamics of the Milky Way,

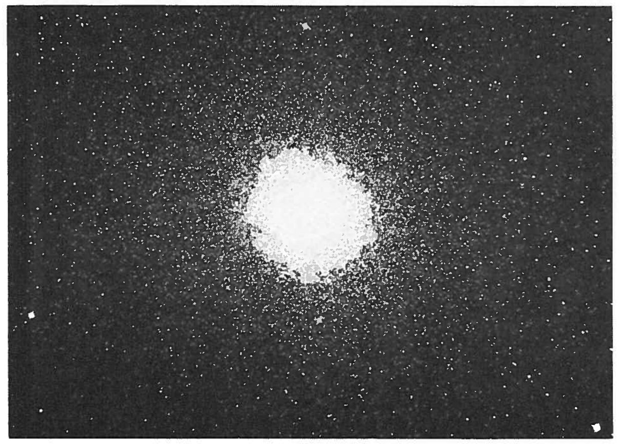
(2) detailed studies of our nearest neighbours outside the Milky Way, the two Magellanic Clouds which are inaccessible to the great northern telescopes,

(3) astrophysical studies related to problems of stellar evolution.

As a result of the first programme our knowledge of the constants of the Galaxy – including the distance of the Sun from the centre of the Galaxy (now estimated to be about 30,000 light-years) – rests on a far firmer foundation. Such constants, determined by optical astronomers, have to be used by radio astronomers in the interpretation of their observations of 21cm (neutral hydrogen) radiation. Radio waves have the advantage of penetrating interstellar smog compared with visible radiation, but attempts to trace spiral structure of the Galaxy by means of the 21cm radiation lean heavily on a dynamical model for the Galaxy built up from optical observations.

One of the first results on the Magellanic Clouds was the discovery of faint variable stars (RR Lyrae variables) with periods of about half a day and about four times fainter than expected.

This provided immediate confirmation of Baade's 1951 doubling of the cosmic distance scale (outside the Milky Way). Subsequent work has included the spectroscopic study of over 200 individual objects in the two systems. This has added greatly to our physical knowledge of stars at the upper limit of brightness, which appears to be about half a million times the brightness of the Sun, and also to our dynamical knowledge of the Clouds. The Large Cloud appears to have a total mass of order 5 per cent that of the whole Milky Way. By contrast, only some half-dozen of the brightest stars in the Andromeda nebula have been spectroscopically studied with the 200-inch telescope.



The southern globular cluster 47 Tucanae.

Globular clusters are important pointers to stellar evolution and they are very well distributed for study in the southern hemisphere. The first globular cluster in the north to be studied in detail proved to be remarkably lacking in metals in its stellar constitution. The well-known southern cluster, 47 Tucanae, was the first to be studied at the Radcliffe Observatory and proved to be remarkably rich in metals for a globular cluster.

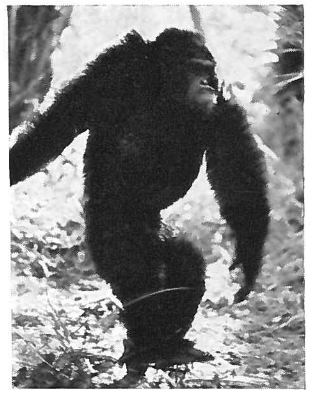
Owing to the strong concentration of astronomical instruments and manpower in the north, the neglected southern hemisphere is very rich in objects of individual astrophysical interest, and doubtless many more remain to be discovered.

Although a large reflector is most profitably used on faint distant objects, two of the rare uses of the Radcliffe reflector within the solar system may be mentioned. The asteroid Icarus which passed within four million miles of the earth in June 1968 has been observed from Pretoria on numerous occasions in order to define its orbit; this had been done at the special request of US astronomers. During the normal opposition the object is so faint that the telescope must be pointed and *guided* blind, according to the predicted motion of the asteroid relative to stars. In 1965 the sun-grazing comet Ikeya Seki was known in advance to be going to become a daylight object, offering the best opportunity since 1882 for observing iron in a comet (the visual observation of 1882 had been questioned). The Radcliffe spectrograph did in fact record photographically both iron and calcium for the first time in any comet.

The Transvaal climate allows the effective use of the Radcliffe telescope for an average of 2,400 hours per annum. It has in fact been so used since 1951 and can claim to be the busiest optical telescope in the world. It was in 1951 that the Trustees and British Admiralty agreed to allow Observers from the Royal Observatory, Cape, to use the equipment for one third of the time in return for a grant to the Trustees. Further assistance from the DSIR and the Science Research Council became possible later through the good offices of the present Astronomer Royal, Sir Richard Woolley. On April 1, 1967 the Science Research Council took over administrative control from the Trustees according to a seven year agreement, with the Trustees still making a contribution from their Astronomy Fund.

Some 75 astronomers in all have used the Radcliffe reflector during its twenty year life. Of these about 40 per cent have come from UK, 30 per cent from S. Africa (mostly from the Royal Observatory, Cape, including UK astronomers seconded from Royal Greenwich Observatory), and 30 per cent from USA, Holland, Australia, etc. During the past ten years an increasing number of visitors from UK universities or from Royal Greenwich Observatory have come with DSIR or SRC support.

Plans for the Anglo-Australian 150-inch telescope and the parallel development of large telescopes in Chile by United States and European organisations represent an increased astronomical interest in the southern hemisphere. The results that have been obtained at extraordinarily low cost with the Radcliffe telescope have certainly done something to stimulate that interest and further benefits will derive from the acquisition of modern ancillary equipment.



chimps with everything

a behaviour study on wild chimpanzees

Jane van Lawick-Goodall

This (second) 'Grants' article illustrates an example of how the Biology Committee of the SRC were able to assist a research programme which, although receiving financial support from another body, was in danger of running down before the completion of the research programme.

This study has been in operation since 1960, financed first by the Wilkie Foundation of Des Plains, USA and subsequently by the National Geographical Magazine. The SRC grant is worth £12,585 and provides salaries for two reseach workers and their African labourers, equipment and consumables, including £2,000 for bananas. It was awarded to ensure the maintenance of the research records.

With every hair on end and looking twice his normal size Mike charged down the mountain slope at his usual breakneck speed. He was dragging a huge dead branch behind him and as he reached more level ground he hurled it before him with the powerful co-ordinated movements of a javelin thrower. With the same effortless control he came to an abrupt halt and, after gazing around for a few moments, sat on the ground. Gradually his coat resumed its normal sleeked appearance. Mike, top-ranking chimpanzee, had arrived. Several other chimpanzees, including a mother with a small infant clinging to her belly, had hurried out of the way, and two humans, binoculars and tape recorders around their necks, had also moved aside. Now the other apes moved towards Mike and made gestures of submission as they greeted him whilst the human observers made detailed notes on the behaviour. The chimpanzees ignored the humans completely.

It was 6.45 in the morning. The scene was the observation area of the Chimpanzee Research Project at the Gombe National Park (formerly Gombe Stream Reserve) in Tanzania, East Africa. On an irregular basis, so as to disturb the natural behaviour of the chimpanzees as little as possible (but approximately once in every seven days) we feed them with bananas. On these occasions the 40 metal boxes, sunk in cement and opened by pressing buttons inside the research building, are filled to bursting with fruit. Today there were no bananas and presently the chimpanzees, in small groups or singly, wandered back into the mountains. One observer set off behind one of the groups to record its behaviour for as much of the day as possible.

I started a study of the Gombe Stream chimpanzees (Pan traglodytes (or satyrus) schweinfurthi) in 1960 with the encouragement of the well-known anthropologist and paelaeontologist Dr. L. S. B. Leakey, and the financial backing of the Wilkie Foundation of Des Plains, Illinois. It was only a small expedition – myself, my mother and an African cook – which landed on the beach. We had two tents (one small one for the cook) a 12 foot dinghy, a few pots and pans, and my all-important binoculars.

The Gombe National Park is a narrow strip of country running for some 10 miles along the lake shore and stretching inland only about three miles to the tops of the mountains of the Rift Escarpment. These mountains are intersected by numerous steep-sided valleys and ravines which support dense gallery rain forest. The upper slopes, however, are covered by more open woodland and many of the peaks and high ridges are treeless. I found that this type of habitat was ideal for observation. From a number of the high peaks I could watch, through binoculars, the normal daily behaviour of the chimpanzees whilst they, at the same time, gradually became used to the strange white ape that had appeared in their terrain. At first they ran off if they saw me 500 yards away; after 14 months many of them permitted my approach to within 30 feet without running off, provided they were in thick forest – out in the open they were still shy.

During my first year I learned that the chimpanzees fed mainly on fruit, leaves and other vegetable foods, but sometimes ate insects and fresh meat. I watched how each individual made its own sleeping platform or nest every night by bending leafy branches over a fork or other suitable 'foundation' in a tree. Only infants, under three or four years of age, did not make nests but shared the large ones made by their mothers. I grew familiar with some of their many calls: the loud pant-hoots which serve as contact calls between the different groups: the piercing screams given by individuals being chased or attacked; the whimpering of lost or unhappy infants; the soft grunting which is the chimpanzee equivalent of human laughter. But the biggest step was when I began to recognize some of the chimpanzees as individuals. There was David Greybeard, the first one to let me approach closely without running off; powerful Goliath who was then top-ranking male; Mr. McGreggor who, with his bald head and bald shoulders, seemed a real old man of the woods; and Flo, at that time mother of three and who, with David Greybeard, would later help to inaugurate the feeding scheme.

Once I knew some chimpanzees as individuals I was able to find out more about their complex social structure – though even now, eight years later, we still know comparatively little about it. These apes do not move about in relatively stable troops as do gorillas and many monkeys. Instead the wide-spread community is comprised of ever changing temporary associations. Only a mother and her younger offspring remain together for any length of time: for the rest, each chimpanzee may be regarded as an individual unit and may travel about on its own for hours or even days, although it joins up, at frequent intervals, with other individuals. There are, however, strong companionship preferences so that certain combinations of individuals are observed more frequently than others.

The old female Flo grooming her four-year-old infant, Flint.

The chimpanzee's range in this area seems to vary from about five to ten square miles (for a mother with young) to some thirty square miles for a male in his prime. Within its range the chimpanzee is a nomad, following no regular circuit in its daily wanderings and sleeping wherever it happens to be when dusk falls. Because of this I was often able to see the same individual only a couple of times in any one month – when my mountain wanderings happened to coincide with his. It was even more difficult to make consecutive observations on interactions between the same two chimpanzees, apart from a mother and her young offspring. A final difficulty, during the early years, was that even when the chimpanzees allowed me to observe from close quarters the thick foliage meant that it was impossible to see all the details or even all the individuals taking part in complex social interactions.

For these reasons it is necessary to maintain our observation area and feed the chimpanzees often enough for them to make fairly regular visits there. Yet the feeding system started very casually, and long before the research had been envisaged as a long term project. It was in 1961 that David Greybeard (as I later identified the visitor) climbed a palm tree by my tent to feed on the ripe fruits. My mother had returned to England by then, but my cook, Dominic, excitedly told me the story when I came down from the mountains, as I did every day, at nightfall. I asked Dominic to leave bananas out in case David should return – which he did. Eventually David began visiting camp just in case there should be bananas. Occasionally I stayed in camp to watch him and thus found out that he was sometimes accompanied by other chimpanzees.

At first the chimps who accompanied David visited camp infrequently and newcomers to the group were few and far between. Two years later five mature males, two adolescents and two mothers (one of which was Flo) with their offspring were the only known chimps visiting my camp. And then old Flo, after four years of maternal preoccupation with her youngest infant, became sexually attractive again. She was followed into camp by no less than eight male suitors with a few young females and adolescent males tagging on. At the time the wild life photographer, Baron Hugo van Lawick, was with me. In 1962 he had spent three months at the Gombe Stream photographing chimpanzee behaviour: now he had returned to devote nine months to the project. The sudden influx of chimpanzees at our camp made me realize that a feeding scheme, on some sort of organised basis would not only be invaluable for obtaining data on a fairly regular basis, but also for the building up of a photographic record of chimpanzee behaviour.

The following year, 1964, was in many ways the start of a new phase in the research project. Hugo and I were married early that year whilst I was in England working towards my Ph.D. degree at Cambridge University. We took on two research assistants to help with the ever-growing volume of notes, and who were prepared to stay on and keep up the records when I had to return to Cambridge the following year. In addition we put up two prefabricated huts at the observation area. This was a necessary step: living in tents as we had been, we were at the mercy of some 35 chimps (the size to which our original group had grown), all of whom delighted in chewing on cloth and cardboard – presumably for the salt content. Our bedding, clothing, boxes of stores, and even the precious scientific records were in constant peril.

From 1964 onwards the project has gradually expanded – although the number of chimpanzees, taking into consideration the births and the deaths, has remained more or less constant. Today we have three graduate students working on the daily record of behaviour of the chimpanzees which visit the observation area. These young people also spend a good deal of time following the apes back into the mountains and observing them under completely natural conditions. Two students who have completed their year of general observations are now working on their own projects. One is working towards a Ph.D. on reproductive behaviour at Cambridge University and the other is undertaking a survey of chimpanzees in the southern part of the Park which do not visit our feeding area. Two students from Berkeley University are studying baboon social behaviour in the area, and a Cambridge graduate has just started a study of the comparative ecology of monkey species in the Park. We have now been joined by Dr. Simpson who will

Two chimpanzees giving pant-hoots in response to calling from a distant group. The mother Mandy on the left is touching the adolescent male Jomo (about 10 years old) for reassurance.

act as Field Director and supervise the students and the routine work in my absence. Because of this expansion we have employed a young couple to cope with the ever growing burden of accounts, buying of supplies, erection of buildings, maintenance of boat engines etc. In 1961 the National Geographic Society (Washington, U.S.A.) took over the full financial support of the project and have continued to be the sole supporter until the current year: now we have been granted a substantial amount by the SRC to cover running expenses, and subsistence fees for two British research assistants, for the next three years. We are extremely grateful for this assistance.

Primate research, in general, is of interest because of the light which it throws onto human evolution and behaviour, and the chimpanzee is of particular importance because of its close likeness to man. A widely accepted clause in the definition of man has been that 'man starts at that stage of primate evolution when the creature begins to make tools to a set and regular pattern.' The Gombe Stream chimpanzees, whilst they cannot be said to conform exactly to this specification, nevertheless use a wide variety of natural objects as tools. Moreover in some instances, by modifying objects to suit them to specific purposes, they actually *make* crude tools. For instance, a chimpanzee will push a grass stem or twig into a passage in a termite nest and then eat the insects which he pulls out clinging to the tool. If a grass is too wide to go down the hole the chimp strips thin pieces from either side; he pulls the leaves from the leafy twig; he trims the end of a piece of bent grass. Another 'made' tool is used for sopping up water (which cannot be reached with the lips) from a hollow in a tree trunk. The chimpanzee picks a handful of leaves, briefly chews them (thereby crumpling them and increasing their absorbancy) and then pushes this home made 'sponge' into the water with his fingers, withdraws it, and sucks it dry. In addition, the Gombe Stream chimpanzees use leaves to wipe dirt, food or blood off their hair and stones or rocks as missiles during aggressive encounters with baboons, other chimpanzees and humans.

In our area the chimpanzees frequently prey on other mammals: the young of bushbuck, bushpig and baboons, and young and adult monkeys. Hunting behaviour often shows a high degree of co-ordination. For example, I watched one adolescent male chimpanzee creep up a tree towards a juvenile baboon. During this manoeuver other chimps in his group moved so that they were standing below neighbouring trees which would have acted as escape routes for the prey. On that occasion the screams of the baboon, when it noticed what was happening, alerted the rest of its troop which rushed up and threatened the chimpanzees – during the confusion the victim escaped. On other occasions similar behaviour has led to the capture of the prey.

One interesting fact which is emerging from this study is the long term duration of the family tie. The period during which the youngster is completely or partially dependent on the mother is long: the first break in mother-infant contact (not including occasions when a child is accidentally dropped) does not normally occur until the sixth or seventh month. The infant continues to suckle, to be carried about by the mother and to sleep with her at night, until it is at least three-and-a-half years, and sometimes even older. The joung juvenile continues to travel in close association wtih its mother – indeed, two females remained almost constantly with their mothers and younger siblings until they reached adolescence at about seven years of age. Moreover, adolescents of both sexes, whilst they frequently move about independently of their families for days or even weeks, usually return fairly often to spend time with their mothers. Two of Flo's sons, both of which have now reached full social maturity (about 12 to 13 years of age), are often observed travelling or socially grooming with Flo: either mother or son may hurry to the other's help during social interactions with other chimps.

Of interest also is the bond between siblings. Juveniles usually touch, play with, groom and carry their infant siblings. On three occasions older siblings (one adolescent female, one juvenile female and one juvenile male) 'adopted' infant siblings after the death of the mothers, moving about with them, allowing them to share their nests, and, in two cases, carrying the infants also. For a long while we have suspected that some of the close 'friendships' observed between mature individuals were based on sibling relationships. Some confirmation is provided by Flo's two mature sons: they frequently travel around together and spend long periods socially grooming each other.

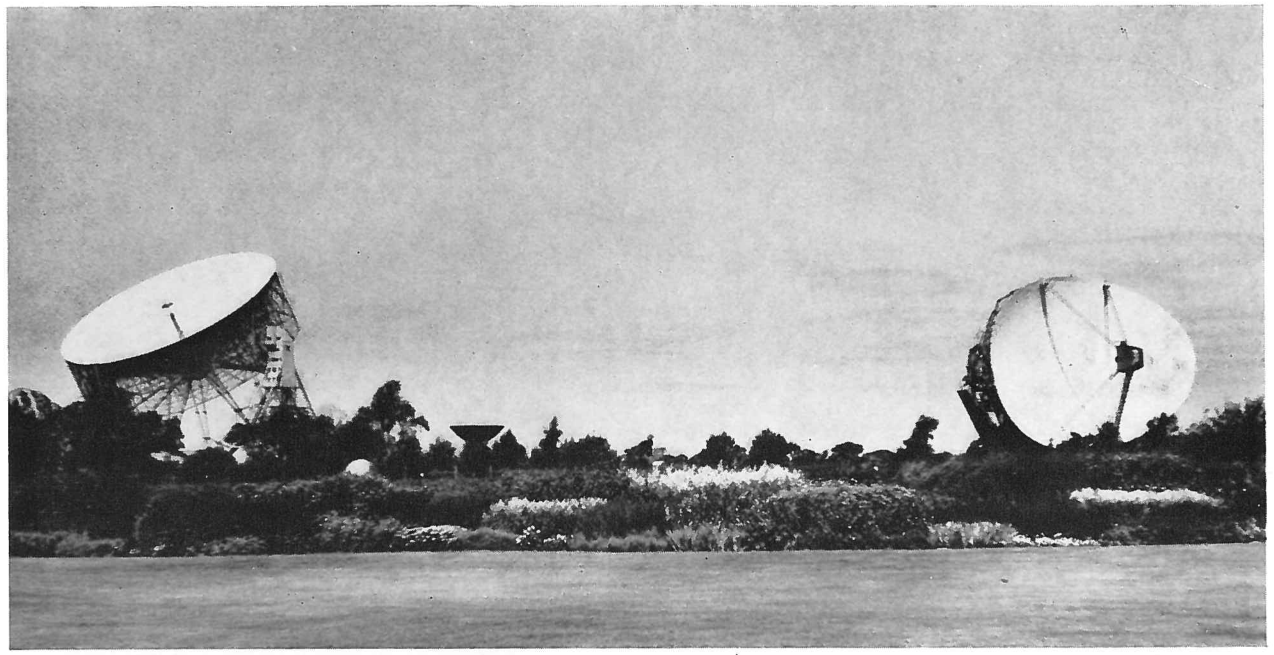
One of the more fascinating aspects of chimpanzee behaviour is the similarity between much of their non-vocal communication patterns and our own. Thus these apes touch, pat, embrace, kiss, bow and hold hands using postures and gestures almost exactly similar to those of man and, moreover, in similar contexts to those which elicit the same behaviour in ourselves. A nervous chimpanzee, for instance, may reach out to touch

The adolescent male on the right Faben is staring at the mature female Melissa's new born infant. She, nervous of his approach, holds out her hand for reassurance – he is gently patting her fingers.

or embrace a companion. A chimpanzee screaming after an attack is reassured by a touch or a series of patting movements given by the aggressor. Chimpanzees greeeting each other after a separation may kiss, embrace or, occasionally, hold hands. This similarity of behaviour has led us to realize that unless the gestures have, by coincidence, evolved along closely parallel lines in man and ape, then they must have a common origin in some ancient ape-like form ancestral to both the chimpanzees and ourselves.

In conclusion one point should be emphasised: that chimpanzees differ from one another in temperament and 'personality' as much as we do. It is only by continuing our study for many years to come, and by covering at least the greater part of the life span (which may be as much as 50 years) of chimpanzees we have known from birth, that we can hope to answer some of the outstanding questions of today. I believe that the task is worthwhile: than an understanding of the closest non-human relative alive today, and which lives in a society that imposes few inhibitions when compared with even the most primitive human tribe, will help us to understand the biological background of much of our own behaviour.

Photographs by Baron Hugo van Lawick.



the smallest radio sources

H. P. Palmer

Quasars and radio galaxies have been in the news for six and fifteen years respectively. They are two of the types of astronomical object which are now known to be associated with discrete sources of radio emission. It is interesting to recall that the first localised radio source was discovered in 1946 by Hey, Parsons and Phillips because they noticed that the intensity of the radio emission from a particular region of our Galaxy fluctuated from minute to minute. They correctly inferred that some of the radio noise from that direction was emitted by a source of small angular size and we now know that these fluctuations were produced by scintillation in the Earth's ionosphere. This source came to be known as Cygnus A, the brightest discrete source in the constellation of the Swan. By 1952, measurements of the radio size of Cygnus A, at a number of observatories including Jodrell Bank, had shown that it consisted of two emitting regions or components, separated in the sky by rather more than one minute of arc. In 1953 Baade and Minkowski, working with optical photographs taken with the 200 inch telescope at Mount Palomar, found a very faint nebulous object which they thought was associated with this source. Their measurement of its optical redshift $\frac{d\lambda}{\lambda} = 0.056$ showed that the source is far outside our Galaxy, and, according to Hubble's law, its distance is 500 million light years. The distance between the components is therefore 240,000 light years, which is larger than a normal galaxy, and radio energy is being emitted at the tremendous rate of 4.4×10^{44} ergs/sec.

As the study of radio sources has developed, some observatories have concentrated on producing ever more accurate and sensitive surveys of the whole sky, discovering many more radio sources and cataloguing their positions and intensities with increasing accuracy. Our optical colleagues have searched for and in some cases found the generally very faint objects with which radio sources can be identified, but the optical appearance of many of the thousands of radio sources now in the catalogues is still unknown. Meanwhile, other observatories have concentrated on measurements of the particular properties of known radio sources, such as their angular size and shape, or the spectrum or polarization of the radio radiation they emit. Since the initial

work on the structure of Cygnus A, the study of the angular size and shape of discrete radio sources has remained one of the major programmes at Jodrell Bank.

the measurement of angular size at radio wavelengths

Instruments designed for this purpose must firstly be sufficiently sensitive to detect the sources to be studied in the presence of unwanted radio noise from the Galaxy etc.; secondly they must have resolving power adequate to distinguish the smallest features of the source which are of interest. At radio wavelengths adequate sensitivity is only achieved with telescopes having collecting areas of one acre or more, while a resolving power of one minute of arc requires that the telescope shall be 1000 wavelengths across, that is, almost a mile at metre wavelengths. The resolving power can be improved, however, by using two telescopes as an interferometer, for then the smallest detail which can be distinguished in the source depends on the baseline or separation of the telescopes, rather than the telescopes' size. This was the method used by Michelson in his classic optical work on the diameters of stars.

For the radio work at Jodrell Bank on the structure of Cygnus A, Professor R. Hanbury Brown and Dr. R. Q. Twiss designed an interferometer working on the new principle of post detector correlation. The required resolving power was achieved easily but this instrument could not be used for the study of weaker sources because it becomes comparatively insensitive as soon as the radio noise from the source is swamped by that generated in the receiver or arising from the Galaxy. In 1952 therefore, construction was started on the radio equivalent of Michelson's stellar interferometer. This instrument was to be operated over the longest possible baselines and broad band radio links used to bring the signals together before detection. Radio links had already been used for this purpose at a number of observatories, sometimes with the approval of the Radio Licensing Authorities. After some initial experiments in 1954 and 1955 which used a radio link operating at metre wavelengths, all the long baseline observations at Jodrell Bank have employed a VHF link to establish the phase coherence of the receivers and a microwave link to convey the noise signals from the remote station to Jodrell Bank for correlation. Fig. 1 is a simplified block diagram of these instruments.

the transit telescope observations

The observations with the first of this series of long baseline interferometers were conducted by Professor R. Hanbury Brown, Dr. Thompson and the author between 1954 and 1957. The largest telescope available to us at Jodrell Bank at that time was the transit telescope and we used it at its shortest convenient operating wavelength of 1.89 metres. We constructed a small portable aerial which could be moved relatively easily from one site to another and made observations with the radio link at five sites in all. The collecting area of the aerials being relatively small and observations being restricted by the transit telescope to a strip of sky near the zenith at Jodrell Bank, we observed significant correlation for only seven sources altogether, but we were able to show, using our longest baseline of 12½ miles (10,600 wavelengths) that three of these sources were smaller than 12 seconds of arc. It followed that these three sources had very high surface brightnesses, which were comparable with that of Cygnus A, the brightest source then known.

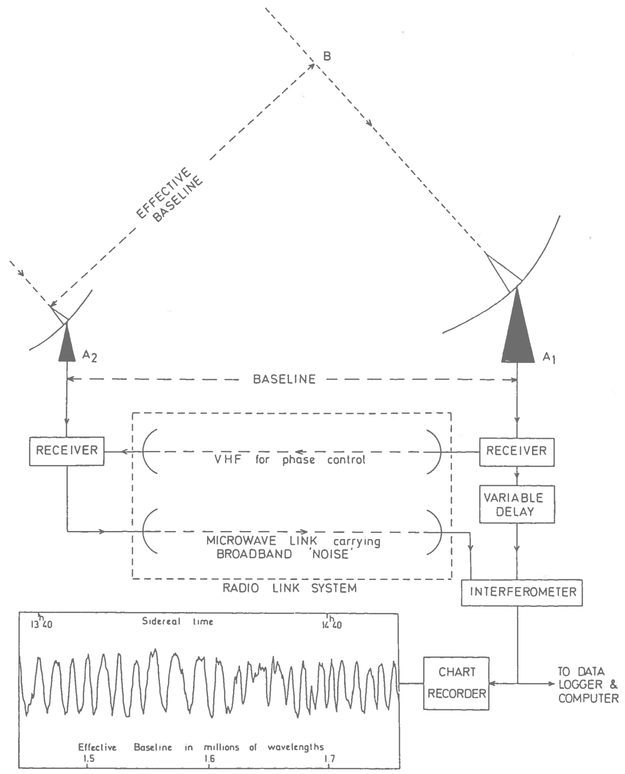


Fig. 1 A simplified block diagram of some of the long baseline interferometers used at Jodrell Bank. The radio link systems may use one or two repeater stations. The fringe pattern shown was that obtained in December 1966 for the quasar 3C 273, with a baseline, at a wavelength of 6 cms, of 2,100,000 wavelengths.

All these three sources were then unidentified, but when these measurements were combined with accurate determinations of their celestial positions from Cambridge and Owens Valley in California, Minkowski was encouraged to study one of them, 3C 295, with the 200 inch telescope. He then found a very faint galaxy which proved to have a redshift of $\frac{d\lambda}{\lambda} = 0.47$ and so is almost ten times as far away as Cygnus A. The emitted power and other features of the galaxy appear to be very similar to those of Cygnus A and it remains the most energetic and remote radio galaxy so far found.

the diameter survey

The 250ft. telescope Mark I was completed in 1957, and may be seen on the left of the picture at the head of this article. It enabled us to study radio sources anywhere in the sky visible from Jodrell Bank, and we improved the interferometer in order to make a more complete survey of source sizes. Initially baselines of 2,200λ and 9,700λ wavelengths were set up and in the next two years almost four hundred sources were observed. Most of the sources appeared to be partially resolved by one or other of the baselines and the results suggested that many had double or complex structures, but they could not be interpreted at all easily. 10% of the sources appeared to be completely unresolved, that is smaller than eight seconds of arc, and it was decided in 1960 that the next stage should be to extend the baseline length to 36 miles (30,000 wavelengths). This still did not resolve all the sources, so in 1961 a second microwave link was obtained and a baseline of 70 miles (61,100 wavelengths) became possible, using (with the co-operation of the BBC) radio link repeater equipment at Holme Moss on the Pennines. With this baseline we achieved for the first time a resolving power of one second of arc and by the end of 1961, almost all the 400 sources studied initially appeared to have been partially resolved at one or more of these four baselines. However five sources had been found which were unresolved by any of these baselines, and so were smaller than one second of arc. The very high surface brightness of these sources again stimulated work with optical photographs, and one of them, 3C 48, was identified shortly afterwards with a star-like object. This later became known as a quasar and today three of these five sources are among the two hundred or so known quasars, while two have no optical identification yet.

the study of the structure of radio sources

All the work discussed so far was carried out with equipment operating at a wavelength of 1.89 metres and using telescopes at the remote site which could be moved to different elevations but could not be steered in azimuth. The radio sources therefore had to be observed in succession as they crossed the meridian at some time during the day or night and an observation of each source only lasted ten or fifteen minutes. The radio noise from the Mark I telescope had to be delayed while that received at the outstation travelled along the radio link. In order that this compensating delay of some hundreds of microseconds should not vary too much with elevation, the aerials were set up as close as possible to an East-West line. These restricted observations gave estimates of the angular scales of the sources but no information about their detailed structures. Towards the close of the observations at 61,100 wavelengths a continuously variable mercury delay line was obtained, and the small timber array which had been built in 1954 was remounted so that it could be steered by hand to follow sources for many hours as they moved across the sky. The effective resolving power of this tracking interferometer, and the position angle in which this resolution was obtained, therefore varied with time. It then became possible to make more detailed studies of the angular shape of a few sources. The most interesting result obtained with this new technique was the discovery that the remote galaxy 3C 295 had a double structure, so increasing further its resemblance to Cygnus A.

transportable telescopes

The success of the observations with the tracking interferometer was one of the arguments used in 1962 to support an application to DSIR for aid towards the construction of a fully steerable radio telescope for use at a remote interferometer outstation. It was to have a collecting area as large as possible and to be so constructed that it could be moved relatively easily from one site to another. The project became known as the Mark III transportable telescope. While this application was under discussion the group at Jodrell Bank decided to construct a smaller transportable telescope with which further tracking observations could be made, while the interferometer and methods for the radio control of remote telescopes were developed and perfected. This 25ft. diameter telescope was completed by the autumn of 1963, and is shown in Figure 2. It was then decided to obtain as great a resolving power and sensitivity as possible by moving it as far away from Jodrell Bank as the radio links would permit, and operating it at the shorter wavelength of 70 cms, as this is near the optimum for the low noise parametric amplifiers which were then becoming available. Significant fringe patterns were obtained quite quickly in this experiment, and after a further six months of development and observation thirty-four radio sources had been studied and no fewer than sixteen of them were found to give measurable fringe patterns. Interesting structures were thus obtained for six more sources, while the five smallest radio sources were still unresolved and so shown to be probably smaller than 0.3 seconds of arc.

still higher resolving powers

By the end of 1964 we were only slightly nearer our aim of resolving all the 384 sources in the diameter survey, and some of the sources added to that list subsequently had also proved to be very small. Still higher resolving powers were clearly needed, and we again compared the difficulties of work at still shorter wavelengths with the alternative of telescopes at sites such as Fraserborough or Goonhilly, which were still more remote, and needed many more radio links. The change to shorter wavelengths seemed to offer more scope within the United Kingdom, especially as Jodrell Bank's new short wave instrument, the Mark II telescope, was just coming into use. (This telescope can be seen on the right of the photograph at the head of this article).

In order to maintain or improve the overall sensitivity of the system we needed a larger telescope at the other end of the baseline and R R E Malvern welcomed our proposal to use one of their 85ft. telescopes for a co-operative programme with our interferometer. In the spring and summer of 1965 a three-hop radio link system was established between Jodrell Bank and Malvern, and two months of successful observation at a wavelength of 21 cms showed that at least five sources had dimensions smaller than 0.1 seconds of arc. In 1966–67 these observations were extended to the still shorter wavelengths of 11 and 6 cms. As the performance of the telescopes and of parametric amplifiers was falling off by 6 cms, only five sources gave significant fringe patterns at that wavelength. One of these has been reproduced as part of Figure 1.

At a wavelength of 6 cms, the baseline from Jodrell Bank to Malvern contained more than two million wavelengths, so the maximum resolving power had increased from 12 seconds in 1956–57 to 0.03 seconds in 1966. The main steps in this advance are summarized in the table on page 18 which also shows that this programme required at least one major telescope for more than 8,000 hours during that decade. The pace has not slackened since, for in the last eighteen months American and Canadian groups have operated interferometers between telescopes on either side of the Atlantic. They used video tape recorders and atomic time standards instead of radio links. The achievement by these means of radio resolving powers of 1/1000 seconds of arc is another very interesting development.

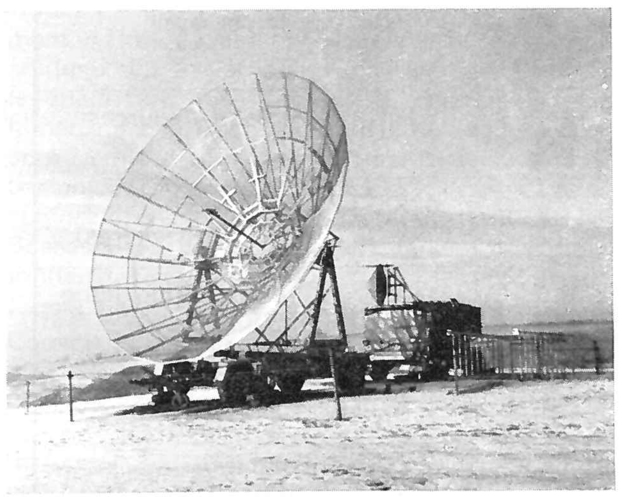


Fig. 2 The 25ft telescope used under remote control at a site in Yorkshire in 1963–4. This telescope is now on loan to the concourse (exhibition) building at Jodrell Bank for use by the public.

work with the Mark III telescope

The radio sources studied in all these observations are amongst the two or three hundred most intense sources known. The Mark III telescope (shown in fig. 3) was designed, and its present baseline selected for an initial survey of the angular sizes of weaker radio sources. It came into full use as part of a tracking interferometer with the Mark I in August 1967. We have since started several parallel programmes to measure (a) the angular sizes of all the sources catalogued in a given area of sky, and (b) sources in some interesting classes, such as Quasars for which optical redshifts are known, or reasonably intense sources for which no optical identification has been made. The table shows that the Mark I and Mark II interferometer has been used for 3,500 hours in the last eighteen months, which is already nearly half as much observing time as was used for similar work in the previous ten years. Each source can be studied from rising to setting at each observing frequency, and there

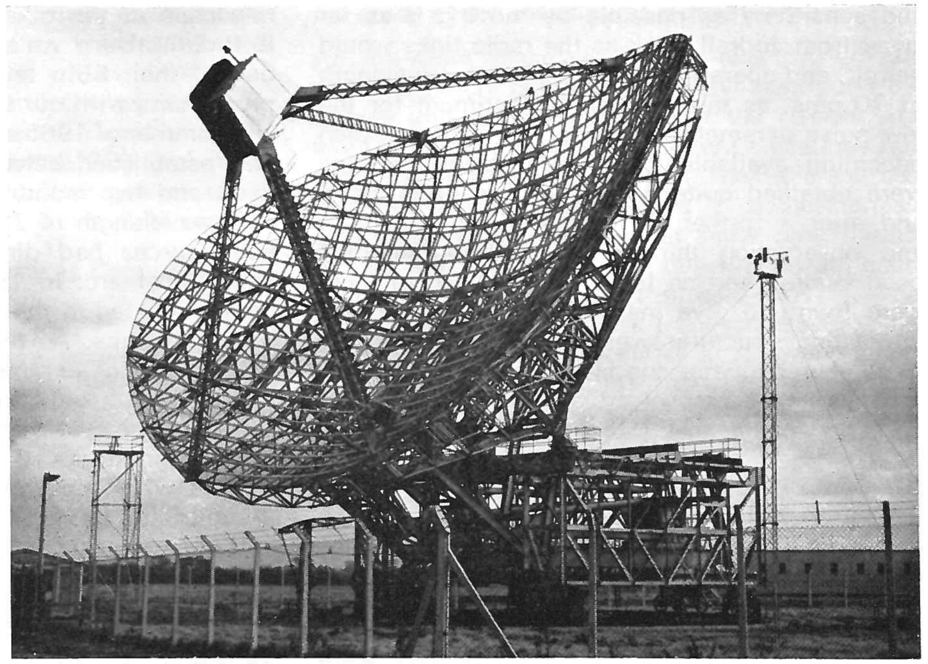


Fig. 3. The Mark III transportable telescope at a site near Nantwich, 15 miles SW of Jodrell Bank.

are more than 1,000 sources which could be detected with this interferometer, using modern low-noise parametric amplifiers. We have now started observing at two frequencies simultaneously, in order to speed up these programmes. If in a few years time we feel that we have completed all useful observations with this baseline and that further data on the sources which change with time are not important, it may then be appropriate to consider moving this telescope to another site. This might even be selected in conjunction with a telescope still larger than the Mark I, known as the Mark V project, which has been deferred for the moment. However, these hopes are in the future and for the present it is sufficient that we can foresee several years of interesting and useful work with this instrument, and there is some prospect that these studies of the sizes and shapes of small radio emitting regions will help in our understanding of the physical processes occurring in radio galaxies and quasars.

a summary of the long baseline interferometer programme at Jodrell Bank

Year	Telescope used	Wavelength (m)	Max resolving power (secs of arc)	Hours of observat on (approx)	Summary of results
1954–7	Transit telescope + small wooden frames	1.89	12	800	sizes of 7 sources
1958–61	Mark I + long troughs	1.89	1.0	4,000	300 sizes (incl. 5 structures)
1963–4	Mark I + 25ft. telescope	0.70	0.3	1,700	16 sizes (including 12 structures)
1965–7	Mark I or Mark II + RRE 85ft. telescope	0.21–0.06	0.03	1,600	45 sizes (including 20 structures)
1966–7 1968–9	Mark I + Mark III	1.9 –0.50	1.5	3,500	300 sizes (including 200 structures when the analysis is complete)

council commentary

Studies on scientific manpower instituted by the Council for Scientific Policy have resulted during the past year in a number of important and much-discussed reports including the Swann report on manpower for scientific growth, with its recommendations for greater emphasis on industrial needs in university postgraduate education. The SRC is one of the bodies to which this report is in effect addressed, and having been closely associated with the working party, had already taken action to meet many of its recommendations. At the January Council meeting there was a full review of the recommendations of the Swann, Jones, Dainton and Bosworth working parties, and the Council confirmed its policies concerning them, as stated in the report of its Training Awards Policy Committee.

A closely related matter was the annual consideration policy on postgraduate training awards. Further increases were made in the proportion of awards for selected advanced courses and for research in collaboration with industry, and some awards were made available for new types of training, of Ph.D. standard, relevant to industrial needs. At the same time some members particularly emphasised the value of the present type of Ph.D. and it was made clear that any new types would not be in substitution for it, but would be intended to meet a different requirement. The allocation of quota of research studentships to particular university departments is made by the Committee concerned, and hitherto the Physics Committee, helped by assessors from the ASR and NP Boards, has made all the physics allocations. For 1969, in the circumstances of increasing selectivity, the ASR and NP Boards were asked to undertake the allocations in their fields.

The broad reviews of SRC policy which the Council is carrying out during the early months of 1969 began in January with the presentation and discussion of the UST Board's review, and it was decided that a number of the reviews of particular subjects incorporated in it should be published in due course. Continuing its policy of concentrating support on chosen fields including inter-disciplinary topics, the Board has set up new Committees on control engineering, enzyme chemistry and technology, and polymer science. In February, the ASR Board's review was presented and discussed. 1968 was a year of exciting astronomical discoveries, in which British astronomers played a big part, including the discovery of pulsars by Sir Martin Ryle's group at Cambridge. The Board's major review of optical astronomy in the southern hemisphere is almost complete, and a corresponding northern hemisphere review has been launched.

Two distinguished visitors attended for particular discussions: Mr. J. C. Duckworth, Managing Director of the National Research Development Corporation spoke about the Corporation's work, and the co-operation with the SRC, which is already close, was discussed further. Dr. A. H. Cottrell, Deputy Chief Scientific Adviser to the Cabinet, who is the UK representative on the NATO Science Committee, joined in the Council's discussion of the NATO civil science programmes. The UK contributions to these is carried on the SRC vote, and after the discussion the Council expressed satisfaction with the programmes.

Besides the more general matters mentioned above, many specific proposals were submitted to the Council for approval including recommendations from all three Boards for schemes or research grants over £50,000. A few examples may be given: firstly an increased core-store for the Rutherford Laboratory central computer, which altogether will then cost £338,000 p.a. to rent. Secondly, a new high-field nuclear magnetic resonance spectroscopy service to be made available to university workers by co-operation between the SRC and the Petrochemical and Polymer Laboratory of ICI was supported by the Council at a cost of £130,000 over three years. Thirdly, a grant of £76,000 to Manchester University for data-processing in molecular spectroscopy, to support Professor G. Allen and Mr. R. F. Warren in developing a sophisticated multi-access computer system for use with chemical instruments. This grant will provide the hardware, and the Ministry of Technology will arrange for the development of the software commercially. The remaining example is worth quoting in full :– 'Not exceeding £55,579, over 3 years, to Edinburgh University for Professor Iggo to support a Somato-sensory Research Group engaged in electrophysiological studies of cutaneous afferent pathways, and in work on the relation between morphology and function of cutaneous receptors.' The reporter humbly records that the Council understood and approved this, and nobody asked whether the object of the research was to find the best form of paw for getting chestnuts out of the fire.

people and their pastimes

parachute jumping

Melanie Gale

Atlas Computer Laboratory

The fact that anyone, male or female, should voluntarily take up parachute jumping as a pastime, is difficult to understand, but why a young, attractive girl should want to adopt such a 'way-out' sport, is incomprehensible.

In an attempt to discover the reasons, and to analyse the attraction, the Editor chatted to Melanie in the air conditioned comfort of the Atlas Laboratory.

E—Melanie, what do you do here at the Lab?

M—I'm one of a group of 24 girls, under the supervision of Dorothy Phelps, who process the programmes sent in by universities and prepare them for feeding into Atlas.

E—Do you like the job?

M—Very much; the work is absorbing and I like this building.

E—I'm fascinated by your choice of a hobby. I first heard of it when I was looking for a caption to the 'Fire Queen' photograph which we used in the last edition and which showed you as joint winner of the AEA fire-fighting competition. Whatever made you take up such a dangerous sport?

M—Well, as you know, I live in Swindon and it's not exactly a 'Swinging City'. It all began when the Girls' Venture Corps held a recruiting campaign and invited people to an airshow at the Vickers airfield in Weybridge. I enjoyed the visit, and together with one or two of my friends, I decided to join the Corps, just to see what it had to offer and to meet a wider circle of friends.

E—How did the parachute jumping bit start?

M—As I've said, I liked the Corps, I had a go at most things and progressed to be a Unit Commander. On the spur of the moment, I volunteered to take the parachute jumping course which consisted of six jumps from heights of ten thousand feet, rising to twenty thousand, with a chance of winning a Duke of Edinburgh award at the end of it. I must admit that I didn't give much thought to the actual jumping; I enjoyed the ground training, which was tough, but good fun, and the actual jump seemed to be a long way off.

E—What happened on the fateful day?

M—I was scared to death. I wanted to back out, but there were six of us in the group, each with an experienced parachutist who was going to make the jump with us, and of course there was that huge Beverley aircraft all ready and waiting. It must have cost a lot to get all that together and the others didn't seem to be scared, so I didn't have the nerve to back out.

Each novice is joined to an experienced jumper by a six yard length of webbing attached at the wrists. This is supposed to instil confidence, but I needed a lot more than a strip of webbing, in fact I felt that I would have preferred to do without it, it somehow restricted me and took the 'decisions' out of my hands.

The aircraft lumbered up to the dropping height and those great doors opened . . . it was 'time'.

I can't describe the exit, except that it was quick and brutal.

I can't describe the free fall either, except to say that I felt sick and more scared than I've ever been in my life – panic scared, but also, when I thought about it afterwards, I felt exhilarated too. You fall headlong and begin to twist for what seems to be an eternity, then the chute opens and it seems to have been no time at all. This part is rather confused, but fear is the uppermost reaction, with lots of other emotions trying to crowd in, but never quite making it.

E—I can well understand your feelings and I admire your courage, but presumably you are now swinging beneath the chute, how do you feel now that the first ghastly experience is over?

M—The tug of the chute checking your fall is quite sudden, and heavier than I expected, but my first reaction was one of surprise – and intense relief – and much to my surprise, quickly followed by a smug self-satisfaction. I looked around and saw the chutes of the others who had gone before me, and I could also see my instructor, who looked comfortable and composed. He gave me a 'thumbs up' and grinned, and in giving him a return smile, I had to fight a desire to laugh out loud. I suppose that was a nervous reaction.

But I felt good and the ground looked very beautiful. The descent was smooth and the breeze warm; I'm told that descending by parachute is similar to skiing or sailing, but as I haven't done either, I can't comment.

E—About the landing; I've heard that they are usually heavy and can be likened to jumping off a truck which is travelling at thirty miles an hour, how did you fare?

M—The landing was not at all bad; I did as I had been taught in the practice sessions and 'soft-landed', rolled over and disengaged my harness. I might add that I had released the webbing before the landing.

E—Having made that first jump, how do you feel about completing the course?

M—Oddly enough I wasn't put off by the thought of repeating the process. I suppose I felt rather pleased with myself. I have since made four jumps, and in each case I have felt all the emotions I experienced in the first fall; but one forgets very quickly and I think you will agree that it's a great thrill. The greatest thrills seem to come with the greatest dangers, and whilst I have every confidence in the chutes, those seconds of eternity are rather frightful.

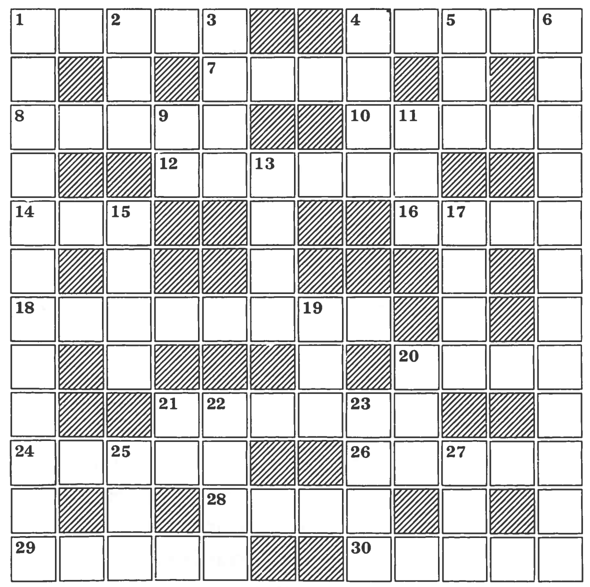
E—What are your future plans?

M—Well I don't think that I shall be able to complete the course. You see I'm getting married in June – to a boy I met through the Corps – and he doesn't like the idea of me jumping out of aeroplanes.

---

crossword

compiled by M. V. Penston, Royal Greenwich Observatory



CLUES

across

1. Not heavy or headless drunk in London Transport
4. Oscillations were around May 8, 1945
7. You have to laugh at endless theorists
8. An entrance is a stone
10. Frequently a loud tone
12. I rang TIM to arrive punctually (2,4)
14. The unknown is Latin for this number
16. Take off from the second office
18. Interrogative magazine and a charged particle
20. The name of lace
21. Fruits which trap plesiosaurs
24. Ensure without 'en' means another application
26. A loin cloth I doth wear
28. A fish tea from United Nations
29. Actresses in heaven
30. My cockney child is a short-lived particle

CLUES

down

1. Unlike most cats these are useful for fitting curve (5,7)
2. Was Portugese not long ago
3. That hen is not now
4. Who is objective?
5. Sixty-nine large vessels in the singular
6. UNO cite Finns over two pies the same (4,8)
9. One preposition or more?
11. After being it, you wont be up it, I hope
13. Thanks to a Greek letter, it takes you home
15. Christmas without a letter
17. This jewel is nothing to a friend
19. Corny, but its work without any tea
20. Tree remains after burning
21. South African boss with a degree
22. Friendly animals, but a nuisance if you twist their tails
23. Made into cheese
25. Initially send us away to America
27. Shortly a workplace for some of us

solution on inside back cover

newsfront

questionnaire

Sixty-one forms were returned out of a possible total of 3,200. If the conclusions of our amateur statisticians can be believed, the result is on a par with the national average for questionnaire returns.

I am more concerned than most that the journal should be a success, and whilst I am by no means satisfied with the response, the consensus of opinion amongst the form filling readers is, in the main, favourable. A few of the comments are reproduced here and they are typical of the 99.99% who were in favour of the journal and who wish it to continue. (I am trying to discover the identity of the 0.01%.)

All the comments have been studied very carefully and wherever possible we will try to meet the reasonable suggestions for improving the journal by making it more readable and more acceptable to the majority of readers.

Your co-operation is appreciated.

Editor.

. . . like to see articles spotlighting the various SRC Establishments, each in turn, . . . so that I can have some idea of what happens where and to whom. Not just a scientific treatise of vague subjects. More People and Places please – and not all Doctors either.

On the whole, Quest is a very worthwhile and enjoyable magazine.

More pages please, and more often.

Has a historical bias – how about looking to the future.

More popular presentation of research programmes.

More sport reporting.

More humour.

. . . one of the few things that has any hope of maintaining a Council-wide esprit de corps . . .

Needs an editorial article and a 'Forward Look' for SRC Establishments.

Presentation greatly improved since issue 1. Cover is mucky.

. . . most interesting subjects are the most controversial, how about a few 'opinion' articles, with a page devoted to replies and comments.

Not so interesting as ORBIT.

. . . do not feel that Quest gives me a coherent picture of SRC identity – perhaps SRC does not have a strong corporate image.

. . . not compulsive reading, but it is improving with each issue.

Excellent magazine.

Articles give an impression of dryness . . . chiefly due to covering too much ground too thinly. Personal articles seem afraid to try to put across what the authors actually felt . . . Road Accident article filled with vague statistics, impossible to draw conclusions from them.

Should be printed monthly, so that it could be 'topical'.

. . .would like to know, in general terms, more of what is going on in the Laboratories/Establishments other than my own.

. . . seems to be aimed at the non-scientist.

No inducement to read . . . Too 'glossy' . . . too 'soft' . . .

We need to be informed of SRC policies, Quest doesn't attempt to do this.

Doesn't appear often enough to make an impression.

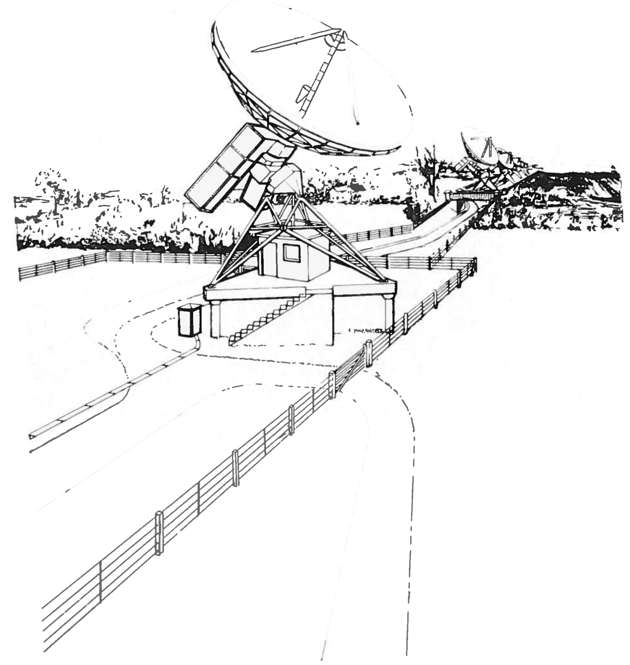
. . . .

This must be the decade of the symbol, because more and more companies, groups and organistions are either producing new symbols or revamping old ones in an effort to maintain a 'with-it' image.

Unfortunately, after having spent a lot of money developing a house sign, they lack the courage to let the symbol stand alone, so that the nett result is a forlorn design which has to have its identity explained by the full name and address of the organisation it is supposed to represent.

The knights and clans of old used colour and pictorial representation more successfully, perhaps because their 'publics' were largely illiterate.

SRC has finally succumbed to fashion and has 'borrowed' the symbol used by Culham, which was a representation of the Newtonian and Cassegrain telescopes together with the Rowland Circle. Unfortunately, the modification to incorporate the letters SRC has rather destroyed the technical accuracy of the design. The symbol has now been approved by Council and it will appear on all SRC literature in the future.



SRC are to provide the two million pounds needed to build a five kilometre radio telescope at the Mullard Radio Astronomy Observatory at Cambridge. This is the observatory which recently made the news with the discovery of Pulsars.

The telescope will enable Sir Martin Ryle, FRS to pursue his technique of aperture synthesis to its practical limit. The technique involves repeated scanning of the sky with aerials spaced at intervals along a track in order to provide data which is progressively built up in a computer to form a map of the sky. The five kilometre telescope will consist of four fixed, 42ft. diameter aerials, and four similar, mounted on rails which will be laid along the site of the now defunct Cambridge to Bedford railway line which forms the northern boundary of the observatory.

The construction will involve laying at one end of the track a very stable concrete beam, three quarters of a mile in length, which will support the rails on which the moveable aerials will be mounted. The fixed aerials will be spaced along the remaining section of the line which runs due east-west. The location of the aerials in position and height relative to each other and to the earth's axis, calls for accuracies far in excess of normal civil engineering work, and a special team of experts will be called in to make the necessary precise measurements.

The Engineering Group of the UKAEA at Risley have acted as SRC agents during the design study, and the UKAEA have been invited to act as agents during the three year construction period.

. . . .

sports day 1969

The second annual sports day will be held this year on Wednesday July 2, and will be at the same venue as last year. (Perhaps we will have better luck with the weather).

Full details of the events and the conditions of attendance for competitors will be circulated nearer the date.

~

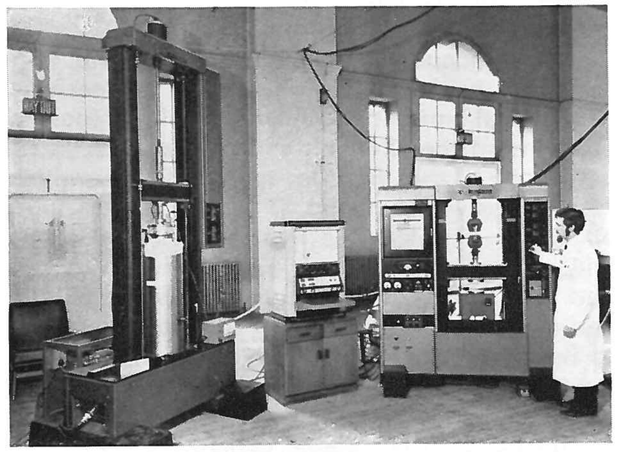
Professor A. W. Merrison, Director of Daresbury Nuclear Physics Laboratory has been elected a Fellow of the Royal Society. He has also been appointed Vice-Chancellor of Bristol University and he will retire from the position of Director when he leaves to take up the appointment in the autumn.

Ariel III completes 10,000 orbits

The first all-British satellite Ariel III circled the Earth for the 10,000th time on February 25 and like Prospero's 'industrious servant', has done well.

In satellite language, most systems are still 'go' after nearly 22 months in orbit, and continue to send back real time data from the experiments while orbiting at a height of about 320 miles at approximately 17,000 mph.

The RSRS and Birmingham, and Sheffield University experiments are still producing valuable information. The recent analysis of the Jodrell Bank experiment data has shown that the radio noise bands observed by Ariel III are probably generated by radiation from electrons in the aurorea; new experiments to confirm and extend this knowledge are planned for UK IV.



Mechanical testing at 4.2°K.
The large Instron on the left has been specially modified to accept the cryostat, where the material to be tested is maintained at 4.2°K.

A small on-line computer being used for automatic data recording from spark chambers.

SRC at the Physical Society Exhibition

Many of the reviews of the Physical Society Exhibition at Alexandra Palace in March, referred to the Rutherford Laboratory exhibit as being one of the most impressive displays in the show.

As the pictures illustrate, the equipment was certainly impressive, especially the large Instron machines which were part of the system of mechanical testing at 4.2°K. The total SRC contribution consisted of three exhibits from RHEL and one from the Royal Observatory Edinburgh.

The Hall Effect magnetic field probe overcomes many of the disadvantages of conventional field measuring instruments, with the added advantage of being direct reading. The model on display shows a probe inserted in the field of a powerful permanent magnet.

The model of the photoelectric guidance display shown by the Royal Observatory Edinburgh, carried a light source to simulate a star and this could be moved in any direction, either manually or automatically, which caused the autoguider to accurately follow the movement.

During a recent official visit to the Rutherford Lab. the Chairman toured the laboratory with Dr. Pickavance and their guest Dr. J. M. Hill, Chairman of the UKAEA.
Prior to the tour, the Chairman addressed the staff in the lecture theatre and had informal talks with the local trades union and staff side representatives.

The Chairman flanked by (L) F. Collins and S. Gregory, Secretary, and Chairman of the TU side of the Local Joint Consultative Committee and L. Smaje (Sec.) and W. Bray (Chairman) of the local Whitley Committee.

crossword solution

Across
1—Light; 4—Waves; 7—Hath; 8—Agate; 10—Often; 12—Ontime; 14—Ten; 16—Doff; 18—Question; 20—Alec; 21—Apples; 24—Reuse; 26—Dhoti; 28—Tuna; 29—Stars; 30—Meson.

Down
1—Leastsquares; 2—Goa; 3—Then; 4—Whom; 5—Vat; 6—Sinefunction; 9—To; 11—Fed; 13—Taxi; 15—Noel; 17—Opal; 19—Oil; 20—Ash; 21—As; 22—Pets; 23—Edam; 25—USA; 27—OBS.

contributors

R. E. Rand, Ph.D.
'an introduction to high energy physics', part 2
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'the world's busiest telescope'
Director, Radcliffe Observatory, Pretoria — *page 7*

Jane van Lawick-Goodall, Ph.D. — *page 9*
'chimps with everything'

H. P. Palmer, B.A., D.Phil.
'the smallest radio sources'
Reader in Radio Astronomy, Nuffield Astronomy Laboratories, Jodrell Bank, University of Manchester — *page 14*