SCIENCE RESEARCH COUNCIL

Report of the Council for the year 1965-66

LONDON
HER MAJESTY'S STATIONERY OFFICE
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Presented pursuant to the Science and Technology Act 1965, Schedule I

Ordered by The House of Commons *to be printed*
18th October 1966

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SCIENCE RESEARCH COUNCIL

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REPORT OF THE SCIENCE RESEARCH COUNCIL

1ST APRIL, 1965–31ST MARCH, 1966

To the Secretary of State for Education and Science

The Science Research Council submit their first Annual Report for the year 1965–66.

Origin, Objects and Constitutional Position of the Council

The Science and Technology Act 1965 which became law on 23rd March, 1965, made provision for the responsibility and powers of the Science Research Council which was established by Royal Charter on 1st April 1965. Under the Act and the Charter, which is given in full in Appendix 1, the objects for which the Council was established were, in brief, to carry out, encourage and support research and development in science and technology; to provide and operate equipment and other facilities for common use in research and development in science and technology by universities technical colleges or other institutions or persons engaged in research; to make grants for post-graduate instruction in science and technology and to disseminate knowledge concerning science and technology.

The creation of the Science Research Council was part of the reorganisation of the arrangements for the Government support of civil scientific research. The Science Research Council, whose members are appointed by the Secretary of State, is one of a group of autonomous civil research agencies the others being the two previously existing Councils for Medical Research and Agricultural Research and two new Councils for Natural Environment Research and for Social Science Research. With all these Councils, the S.R.C. both by virtue of the continuation of the former responsibilities of D.S.I.R. and by contiguous scientific interests, has close relations in the support of post-graduate training and research and in the concerted formulation of scientific policy.

The Research Councils are under the aegis of the Secretary of State for Education and Science who allocates resources between them on the advice of the Council for Scientific Policy. Within their own terms of reference, however, the Research Councils continue to embody the concept established by the Haldane Committee in 1918 of autonomous bodies that are free to determine their own scientific policies and research programmes within the financial limits laid down by government but without being tied to the day-to-day needs of government.

Responsibilities of the Council

The responsibilities of the Council were described in the following terms by Lord Champion, Minister without Portfolio, when introducing the second reading of the Science and Technology Bill in the House of Lords on 4th February, 1965:

> "The Science Research Council will take over the present responsibilities of the D.S.I.R. for giving research grants to universities and post-graduate training awards. Grants for the support of applied as well as pure science in universities are to be the responsibility of the Science Research Council, although the Ministry of Technology will undoubtedly

want, on occasion, to meet its own particular needs with university work, which it would normally do by placing contracts.

The Council will also be responsible for certain facilities which provide services for university scientists. It will take over the National Institute for Research in Nuclear Science, the Royal Greenwich Observatory, the Royal Observatory at Edinburgh, the D.S.I.R. Radio Research Station and the responsibility for supervising the Scientific Space Research programme. It will also in consultation with the Department of Education and Science and the Foreign Office, have primary responsibility for the conduct of United Kingdom participation in international research bodies, such as the European Organisation for Nuclear Research and the European Space Research Organisation".

These responsibilities, particularly those for giving research grants and post-graduate training awards entail close contacts not only with the other four Research Councils but also with the Royal Society, the University Grants Committee and the Ministries of Technology and Aviation and to a lesser degree, other government departments and agencies with research interests. These contacts are maintained by frequent informal consultations and by the appointment of assessors to the Council, Boards and Committees where this seems mutually desirable. In particular, assessors from the Ministry of Technology have been appointed to the committees which deal with grants and awards in applied science and technology.

In the transition period of the year under report, the Council acted as the agent of the Natural Environment Research Council and the Social Science Research Council in the management of research grants and post-graduate training awards.

Organisation of the Council's Work

To help them to discharge their responsibilities the Council have set up three Boards, each with its own staff Division. The Boards and their special fields of responsibility are:

(i) Astronomy, Space and Radio Board:

Research grants in Astronomy, Space and Radio Research.
Space Research Management Unit.
Royal Greenwich Observatory.
Royal Observatory, Edinburgh.
Radio and Space Research Station.
European Space Research Organisation.

(ii) Nuclear Physics Board:

Research grants in Nuclear Physics Research.
Rutherford High Energy Laboratory.
Daresbury Nuclear Physics Laboratory.
European Organisation for Nuclear Research (C.E.R.N.).

(iii) University Science and Technology Board:

Post-graduate Training Awards in all subjects.
Research grants in Mathematics, Biology and Biochemistry, Physics

(all fields not covered by the Astronomy, Space and Radio Board and the Nuclear Physics Board), Chemistry, Engineering, Computing Science, Metallurgy and Materials.
Atlas Computing Laboratory.
N.A.T.O. Scientific Research and Training Programme.

The membership of the Boards and their Committees is given in Appendix II.

The Astronomy, Space and Radio Board and the Nuclear Physics Board began work in April, 1965, but in order to ensure that there would be no interruption of the machinery for supporting post-graduate training in the middle of the university academic year, the Research Grants Committee and the Post-graduate Training Awards Committees of the Department of Scientific and Industrial Research continued their work until September, 1965, when they were re-organised to form the University Science and Technology Board. The Human Sciences Committee of D.S.I.R. also continued in being and reported direct to the Council until most of its functions were transferred to the new Social Science Research Council on December 1st, 1965. On this date the remainder of its functions were transferred to the University Science and Technology Board.

Balance of Effort

The first year of operation of the Council has of necessity been one of assimilation and consolidation. In spite of their diverse origins and histories the constituent parts of the Council have in common the tasks of carrying out or encouraging basic research in science and technology and providing facilities and services for university users. The Council's work and policy is therefore closely linked to higher education, its needs and its growth.

The expenditure by the Council in 1965–66 on their different activities which amounted to £28·2m, is shown in detail in Appendix III and in Diagrams 1 and 2 which show the distribution of research funds by disciplines and by sectors carrying out the research. The diagrams also show the predominance of the support given to fundamental science and in particular to nuclear physics in the total programme of the S.R.C.

The distribution of effort in 1965–66 was mainly determined by the commitments inherited by the Council from their predecessors, the Department of Scientific and Industrial Research, the National Institute for Research in Nuclear Science, the Office of the Minister for Science, the Scottish Home and Health Department and the Ministry of Defence (Navy Department). These commitments, national and international, left the Council only limited scope for initiative and manoeuvre. The Boards and the Council have devoted much effort during the year to the review of the fields of research for which they are now responsible and to the consideration of the desirable future research programmes. But the Council are conscious that they have only made a beginning on the difficult and continuing task of reconciling the requirements of the different fields of science and technology within their responsibilities and of advising the Secretary of State and the Council for Scientific Policy on the nature and measure of support required.

Because the Council's activities are so closely linked to the nature and rate of growth of higher education, two factors which affect the future planning

of the Council stand out clearly: first, the need to provide advanced training of the right kind and for the right proportion of the growing number of graduates in science and technology; and second, the need to support research in universities and colleges so that they may take their proper place as an integral part of the country's whole research effort. The development of international research programmes, especially in C.E.R.N. and E.S.R.O., is a further factor which involves substantial and increasing sums to which the Council is committed by prior agreements. Other factors of importance are that substantial expenditure on national facilities and programmes is essential if university workers are to derive benefit from the existing installations and from related international organisations: expenditure on large capital projects, of which there are many in the Council's programmes, is slow to mature and a five-year rolling plan with firm assurance of the funds available for the first three years, is the minimum essential for the sensible formulation of policy; and, since some projects may take over seven or eight years to complete, the plan must be extended in outline up to ten years ahead.

All these factors are being taken into account in determining forward plans and the balance of support between the Council's various responsibilities. Although the acceptance and phasing of the large projects pose the most severe problems, the Council must also have regard to the widespread support required in other branches of science and technology. Many individual research grants are relatively small and may not yield spectacular results, but collectively the resulting scientific advances play an important role in improvement of industrial techniques and productivity.

The Council will give continuing thought to these and other aspects of research in their endeavour to create the conditions for the best possible balance of scientific and technological progress in future years. Flexibility in planning is essential to meet the changing needs in the different fields of research but the Council has heavy existing commitments and in the present phase of building up research capacity, there is, as yet, little scope for closing current projects to free resources for new work.

It will therefore be very difficult to obtain the necessary flexibility unless, for the next few years, the rate of growth of the Council's funds remains about as high as in recent years. The present stage in the Council's consideration of the special problems involved in forward planning, in the selection of targets for research and training and in balancing competing priorities, will be evident from the later sections of the report.

The Selective Support of Education and Research

The responsibilities assumed by the Science Research Council now cover the support of basic research in the physical sciences, biology and technology. Much of this research is conducted in universities and colleges or by university workers using special facilities elsewhere. The basic framework for university research is provided by the Universities themselves with funds from the University Grants Committee. This determines, as a matter of national policy the size and location of academic staff and the buildings needed to house them. It is accepted, however, that such provision does not enable the research potential of university staffs to be fully used.

In the fields for which it is responsible therefore, the S.R.C. has the duty of ensuring that this potential is developed to its full extent. In its grant-giving activities, the Science Research Council is wholly concerned to give specific help to selected projects of high scientific merit. It is helped in this selection by expert advice from scientists in the universities, industry and government. But the breadth of its responsibilities obliges the S.R.C. to take a national synoptic view of science in general and of academic research in particular.

A high priority in the Council's operations is to ensure that the optimum number of able young scientists and engineers are financially supported to enable them to receive either research training or advanced postgraduate instruction. These people are a scientific élite and include most of the future leaders in research and development as well as a growing proportion of the administrators needed by government and industry in a technological age. Without them neither British industry nor our Universities can sustain a rising level of scientific and technological achievement. The Council is concerned with the determination of the optimum number to be trained and, in consultation with universities and industry (and other potential employers) in ensuring that the quality and type of training given is appropriate to present day needs. Support for the traditional Ph.D. training in the basic sciences by S.R.C. and from other sources, seems broadly to meet the demand for such training and to fulfil the national needs at the graduate and doctoral levels for university teaching and for research in industry and government. The Council is not satisfied, however, that the training which it supports for purposes other than research is meeting the country's needs either in quantity or character. There is an increasing demand for scientists and engineers with postgraduate training to assume a wide range of administrative and managerial responsibilities at a comparatively early stage in their careers and the Council is giving thought to the kind of scientific and engineering training such people need. In this field, the quality and numbers of students coming forward for advanced studies are also of great importance. In consequence, the Council has decided to review their policy in support of postgraduate training in order to give special attention to training which meets the needs of industry. The Council are very conscious that what they can ultimately achieve will be influenced by current reforms in school and university education and will be largely dependent on industry's ability to formulate and declare its needs.

In universities, the most advanced teaching, including research training up to the Ph.D. level, is inseparable from the conduct of research. D.S.I.R. in the past supported both these functions; S.R.C. has inherited them and is trying to reflect their association in universities by closer integration of the support afforded by training awards and research grants. The growth of universities and colleges of advanced technology, the greater emphasis on science, the acceleration of scientific discovery and technological development and the far greater complexity and cost of research, have together put a radically different responsibility on to a scheme which was designed fifty years ago to provide modest aid for researches of special timeliness and promise. The number and size of grants, the kind of activities supported, the speed of reaching decisions, and the conception of a planned policy of

support have all developed dramatically during the last ten years. Nevertheless, the basic principles of the scheme remain as originally conceived—the selective support of research of timeliness and promise judged by the applicant's own peers, on grounds of scientific merit, probable economic worth and, above all, on the ability and scientific potential of the applicant.

The Science Research Council is pursuing in close collaboration with the universities a vigorous policy to ensure the continuing vitality of university science. It is the concern of the Council that their plans should not only develop at a rate which will match the expansion of the universities and the rapidly growing needs of modern research; but also that they should be able to deal with new situations which are continually arising.

The policies of D.S.I.R. in encouraging academic research and the concomitant growth of universities naturally led to a great increase in expenditure on research grants from about £⅓ million in 1956 to the present figure which is well over £5½ million a year. This scale of support and its future trend raise problems which require the constant attention of Council. The help which D.S.I.R. and now the S.R.C. is giving in this way, supplementing the U.G.C.'s support for universities, has played a major part in making it possible for British university science to enter a new phase of research activity. The most modern instruments, large scale equipment, automated procedures, teams of research assistants and technicians are now becoming commonplace. By helping to provide these the research grants scheme has made it possible for the U.K. to match the achievements of other advanced countries in many, if not all, fields of research. In great measure this has only been made possible with the help of many university and other scientists who give time and effort on committees as advisers, referees, and in other ways.

The growth was slow to start, became very rapid, and is now settling down to a rate related to the continued growth of universities and the increasing complexity of scientific research, sometimes called "sophistication". It is the assessment of the right rate of growth which is one of the Council's most difficult problems. In addition to the rising numbers of university staff, fellows and postgraduate students, there are the special needs of new universities and the C.A.T.'s transformed into universities, all naturally enthusiastic to build up the attraction of good research groups much more rapidly than the growth of student numbers. There is also the problem of replacing equipment that becomes obsolete more and more quickly as new techniques and greater refinement of measurement are developed; for example, an essential modern instrument for chemical research may cost tens of thousands of pounds nowadays whereas a few years ago its counterpart cost thousands and a generation ago hundreds of pounds only.

The quality of present day scientific work is vitally dependent on equipment of the highest standards. If these are not maintained research in the U.K. will suffer seriously by comparison with that in other advanced countries. It is S.R.C. policy in consultation with the U.G.C. and the universities themselves to help university research workers to secure the equipment they need.

Research grants provide support for researches conceived within the universities and, in the past, many of these lines of work have been continued

with University support when the initial grant ended. But the rate of growth, and the scale of operations, and, more especially the need for research councils to preserve some measure of influence over the use of the national resources for science, have caused the "take-over" of research projects i.e. the transfer of financial responsibility from research council to universities, to be re-examined with great care. In consultation with the U.G.C., the Council has decided it will continue to support a larger volume of current research in 1967 than D.S.I.R. did in 1962 but that the underlying policy of take-over should be re-examined before the beginning of the quinquennuim 1972–77.

The selective approach to the support of scientific research leads naturally to the concept of national facilities where equipment beyond the capacity of any one university can be constructed and operated for the use of any university. The need to pursue some kinds of academic research in institutions at a distance from universities, though inevitable, may cause difficulties. But the experience of nuclear physicists shows that the organisation of university teaching and research can be successfully adapted to this end.

The use of research facilities at a distance is also becoming a commonplace in computing, astronomy, space and radio research where both national establishments and university research grants are provided by the Council. Investment policy in capital facilities in national establishments can then be planned in relation to University developments as a whole and it is the S.R.C.'s task to try to establish and preserve a reasonable balance between the two.

By a natural extension due to their magnitude and peculiar needs nuclear physics and space research require international facilities as well. Here the policy making is shared with other countries but the U.K. is a major contributor, and has entered into long term commitments to construct and use unique facilities in C.E.R.N. and E.S.R.O. It is essential that we should derive the maximum value from our collaboration, which means that the national programme has to be planned as an essential complement and support to the overseas operations. The balancing of these two components is a concern of the Nuclear Physics and Astronomy, Space and Radio Boards, whilst both this balancing and its relationship to all the other fields of science supported by the S.R.C. occupies an important place in the policy discussions of the Council.

Overall, the S.R.C. has the task of assessing the needs and determining priorities for all these diverse activities and particularly their growth in the near future. A balance must be struck between the claims of post-graduate instruction, research grants, the needs of the different branches of science and technology and the support required for national and international facilities. The Council has to make the case for the funds required for what it considers should be done; finally, it is the task of the Council to ensure that the funds provided are used in the most effective way.

UNIVERSITY SCIENCE AND TECHNOLOGY BOARD

This Board has assumed the responsibilities of the former Research Grants Committee and Postgraduate Training Awards Committee of D.S.I.R.,

together with the substantial commitments to the general pattern of procedures established by D.S.I.R. for making training awards and research grants to universities. These procedures have proved their value over many years and have been modified to meet changing needs during the very rapid growth of the last few years. Reference has already been made to some of the chief policy issues in these fields which are exercising the Council. These merit more detailed discussion here.

Postgraduate Training Awards

There are clearly two main policy issues:—

(1) how many postgraduate students should be supported by the Council;

(2) for what type of training and in what disciplines should these awards be made.

In 1965–66 over 2,800 new Studentships for research training and for postgraduate courses of instruction were awarded, while about 150 eligible applicants, all for training in pure science, could not be given awards. The number of awards current, i.e. the new awards and those continuing from previous years was more than 5,700 and their distribution by subject is given in Appendix IV (Table II). Of the British postgraduate students at the universities, in the fields of science and technology covered by S.R.C., approximately half are supported by S.R.C. awards. The number receiving S.R.C. awards is approximately 19 per cent. of the number who graduated in science and technology at the end of the previous academic year. This level of support is the result of the application of the experience and knowledge of those best qualified to judge the emphasis which should be given to postgraduate training in relation to its cost, the requirements of industry which are not easily formulated over the whole range of studies, the needs of university research and the aspirations of the students themselves, including the attractions of scientific careers overseas. As stated earlier in the report the Council is not satisfied that, apart from training in research, the present arrangements for postgraduate education are meeting the national need. They have therefore appointed a small group under Lord Halsbury to review these arrangements and to make recommendations on future policy. Meanwhile the judgment of the Board and the Council is that the S.R.C. should continue to support the postgraduate training of about the same proportion of the growing numbers of graduates in science and technology.

Training for Industry

Over 80 per cent. of the S.R.C. studentships awarded in 1965 were to students who had just graduated, and usually, therefore, had no experience in industry. There is, however, little doubt that it is desirable for more of the most able young scientists to devote their talents to industrial projects upon which the national prosperity is so dependent. Advantages would accrue both to universities and to industry if young scientists could be encouraged to gain first-hand industrial experience before receiving postgraduate training. New schemes have therefore been devised to this end and also to encourage those already working in industry to undertake

postgraduate training of value to them in their industrial careers. In the latter case, through the Council's new Industrial Studentship schemes, employers can now supplement an S.R.C. award to an employee so that his pay while a student will not be reduced. Last year, fifty studentships were awarded to candidates in industrial employment and in 1966 one hundred and fifty studentships have been made available for immediate award. It is hoped that many of these will be Industrial Studentships with the employer contributing to the student's award.

Appreciation of the usefulness to many students of industrial experience prior to postgraduate training led the Council to approve a scheme, to begin in 1966, whereby new graduates who qualify for an S.R.C. award, can arrange for their postgraduate studies to begin after one to five years in industry. It is hoped that this scheme—known as Science and Industry Awards—in conjunction with the industrial studentships, will persuade many more young graduates to broaden their experience by industrial work before taking up postgraduate studies.

This was the first full year of operation of the Industrial Fellowship scheme which was announced in the last D.S.I.R. Report. This scheme enables the older and more established scientist after some years of industrial experience to undertake postgraduate study, the cost being shared between S.R.C. and his employers; eleven awards have been made.

Review of Advanced Courses

Some eight years ago D.S.I.R. introduced its Advanced Course Studentships scheme. These are awards to support well-qualified postgraduate students who do not wish to choose research as a career but need to supplement their basic undergraduate training with more specialised training in their chosen field, or to supplement their first degree with advanced study in a related field. The scheme grew slowly at first, but during the last four years it has flourished. More than seven hundred awards were made in 1964–65 and over nine hundred in 1965–66. The position has now been reached where approximately one-third of all new S.R.C. awards are Advanced Course Studentships. In providing training for those who are going into industry or Government service, and enabling those with a basic training in one discipline to specialise in some particular aspect of it or to change their discipline, particularly to enter some of the inter-disciplinary areas of special potential interest, the Advanced Course Studentships scheme has been successful. The scheme has enabled many Universities to initiate courses, many of which have proved their worth. However, after a few years of such rapid growth it seemed desirable to review all the courses which had been accepted, in order to concentrate the Council's limited resources on courses of particular value, especially those relevant to industrial needs.

This review was undertaken during the year and, as a result about fifty courses have been selected and will be given priority in the award of studentships. About two hundred more courses will be given support by the normal means of allocated quotas of awards, and a further one hundred are acceptable but awards will only be made individually as required. About one hundred courses have been removed from the list as no longer

needed. Some of the decisions reached have necessarily caused disappointment, but there is no doubt that there will be great gain from the more selective distribution of awards. The Board will review year by year the classification of courses.

Research Fellowships

In 1965–66, 149 Research Fellowships were awarded (see Appendix IV Table I). There were 12 qualified and recommended candidates for whom there were not enough awards. New arrangements for dealing with applicants for Fellowships in North America were in operation for the first time and were successful in aiding the return to Britain of 41 scientists at postdoctoral level. While the Board is satisfied that these Fellowships play an important part in providing support for young scientists of outstanding merit, the Fellowship scheme is now receiving further consideration in relation to the provision of postdoctoral research assistantships under research grants. The Council's policy of integrating training awards and research grant activities facilitates the examination of such problems which, since they involve scarce and highly trained manpower, are of considerable national concern. The Council believe that access to laboratories of international repute overseas can be of special benefit in broadening the outlook of young scientists. S.R.C. Fellowships and Studentships (including N.A.T.O. awards) provide a ready means to these ends and the Council therefore propose to continue to encourage suitable holders of awards to go abroad for a limited period of training. The Council would particularly like to see this done more extensively to countries in Europe, where interchange can be of special benefit.

The reverse movement of postdoctoral and more senior research workers is also encouraged by the Council's Senior Visiting Fellowship Scheme (Appendix V Tables III and IV). In this case the Fellowships are linked with and financed by research grants for particular projects in which the training and expertise of the fellow selected is judged to be of special value to the host university in the U.K.

Research Grants

Applications for research grants to D.S.I.R. were increasing recently at over fifty per cent per annum and annual expenditure over the past seven years has multiplied about ten-fold. The rise in the demand is now less rapid although, in the fields for which the University Science and Technology Board is now responsible the value of grants awarded in the academic session 1964–65 was £5·6 million. In considering the funds likely to be needed for the next few years the Council is examining all the factors likely to affect the demand.

Most grants are made for specific projects in response to applications from research workers, with the approval of their university or college. Broadly, therefore, the pattern of research support is determined by the proposals for research of timeliness and promise submitted by the universities. However, the high degree of selection which must be exercised between worth-while proposals in different subjects in the light of national needs has already begun to influence research trends. Past reports by D.S.I.R. have pointed to a growing emphasis on the support of applied science and technology.

The directions in which postgraduate training and research evolve should be substantially influenced not only by academic but also by industrial and other national needs. Accordingly the specialist committees of the University Science and Technology Board also include representatives of industry, research associations and government, particularly the Ministry of Technology and the National Research Development Corporation. Special steps have been taken to ensure collaboration with the Ministry of Technology and the other research councils in the support of research and development in science and technology. In the applied sciences specially the committees are reviewing fields of research to identify those subjects in which the national interest requires work to be done and for which developments within the universities might be encouraged in order to ensure adequate basic research and training facilities. Independent experts are invited to help, as necessary, in surveys of this kind. Fields at present under review include:—

Large electrical power-generating plant and motors;

Materials for electronic and magnetic applications;

Ceramics—particularly research problems associated with the improvement of techniques for fabricating ceramics and refractory materials;

High-temperature processes (above 2500°K)—chemical flames, plasma devices, augmented combustion and shock-tubes;

Electro-chemistry—electrosynthesis, batteries and fuel cells, corrosion and treatment of metals;

Coal combusion—especially in relation to power generation;

Industrial aerodynamics—external airflow (wind forces on structures) and internal airflow (ventilation and flow in pipes and ducts).

Production engineering—with particular reference to metal forming and machining.

In the basic sciences, which receive a major share of the funds provided by the University Science and Technology Board, steps are also being taken to identify new fields of study especially in chemistry and biology, where special encouragement may be required.

The recommendations of earlier reviews of this kind are already being put into effect. The concerted programmes on brittle fracture are now well under way, the total investment in this programme being about £263,000. A survey of potential growth centres in the country for computing science has led to a series of grants providing a substantial measure of support. Additional large grants in this field have been made during the period under review at Oxford, Edinburgh and London, the total value of these grants being more than £200,000. Reviews undertaken by professional bodies and other agencies are also of value to our committees. For example, a grant of £61,000 to Cambridge in support of computer-aided engineering design is in accord with one of the recommendations of the Feilden Report, as are two of the grants for computing science one of which, to Imperial College, is linked with a research contract placed by the Ministry of Technology on ship design. An expansion of effort in computing science and in the application of computers generally may be expected when the implementation of the Flowers Report on Computers for Universities and Research Councils begins to take effect.

The Board are encouraging collaboration between university departments ; for example, between chemistry and chemical engineering in electro-chemical reactions, and between a number of departments dealing with aspects of materials science. Such collaboration is important in view of the increasing cost and complexity of much of the research equipment required today in universities. In some instances Council has arranged that major facilities should be shared. For example, grants amounting to over £100,000 have been made to support the scheme set up by the Colleges of London University to make generally available expensive instruments housed in various parent Departments of Chemistry.

During the year, a panel under Professor G. Porter has examined the possible economic and scientific advantages of setting up a National Instrument Centre—primarily for all kinds of spectroscopy. The investigation has aroused widespread interest among many classes of potential users. The findings of the panel are now under consideration. Another example of the use of S.R.C. funds to encourage the sharing of facilities is the arrangement made for university workers to have access to major facilities in U.K.A.E.A. establishments for which the S.R.C. pays an annual rent.

Much of the fundamental research which the Council supports in universities will provide the basis for industrial applications in future years. The time lag between research and application and the direction in which development will proceed cannot be foreseen but the increasing emphasis which the Council is placing on the support of technological research promises to yield results of industrial importance on a shortened time scale.

One example arising from collaboration between university and industry is the work carried out since 1959 by Professor S. A. Tobias and his colleagues in the Mechanical Engineering Department of Birmingham University. This research, which covered a wide range of machine tool projects, including problems of vibration, control, and conventional and new forming processes, was supported by grant-aid from the former D.S.I.R., and now the S.R.C., to the total value of about £175,000. Of this overall grant, a sum of about £20,000 was awarded for the continuation of investigations on high energy rate forming originally initiated in the Department in collaboration with two industrial firms. One of the products of this work is the machine now generally known as Petro-Forge. This is a new type of high speed forming press in which a petrol combustion process is used as the energy source and which has considerable advantages over conventional drop forge and mechanical or hydraulic presses.

To follow up this research, the Ministry of Technology has placed contracts worth £192,000 for the development of Petro-Forge machines, as well as associated processes. Of this amount, £162,000 has gone to the University of Birmingham and £30,000 to the Drop Forging Research Association for a study of industrial applications.

The Council is well aware of the benefits to the national economy that could arise from the successful application of adaptive computer control to industrial processes. Research grants for the study of the principles of adaptive control amounting in total to about £500,000 have been awarded to several university departments. Most of these researches also involve close collaboration on a large scale with industry.

One example is the work of a group at Cambridge under Professor J. F. Coales to which a grant of £273,250 has been made for an investigation into adaptive computer control of complex processes. Data from actual plant will be required and at least six large industrial concerns have offered to co-operate. Concentration of expertise in strong research groups such as that established with S.R.C. support in the Institute of Sound and Vibration at Southampton should also facilitate the forging of effective links between universities and industry.

Through the use of its funds in the ways outlined the Science Research Council has in 1965-6 been able to strengthen and influence the course of research in the universities and the stimulus it gives to teaching and the training of men and women for academic, industrial and professional careers. While the Council will continue to give support to promising and imaginative individual researches they will particularly seek to help in building up strong research groups making efficient use of facilities by collaborative schemes within universities and between universities and other bodies. The Council's policy in developing their scheme for postgraduate training will help to provide the research teams which such schemes require and in which they can be most effectively used. The Council believe that the bringing together of research grants and training awards under the University Science and Technology Board will allow greater flexibility in devising schemes to further their common aims.

N.A.T.O. Science Committee

The Council took over the responsibility that D.S.I.R. had held since 1959 for financing the United Kingdom contribution to the science programmes of the N.A.T.O. Science Committee, namely the Science Fellowship Programme, the Research Grants Programme, the Advanced Study Institute Programme, and the Operational Research Programme. The United Kingdom contribution to the £1·5 million total in 1965-6 was £305,000, of which £125,000 was returned to the Council under the Science Fellowship Programme.

These Programmes have been the principal means by which the Science Committee has set out to achieve its aim of strengthening the basic scientific potential of the Alliance, by promoting and facilitating scientific exchanges, discussion, and international co-operation.

The Advanced Study Institute Programme has achieved a high reputation, and is valuable to the United Kingdom since there is no equivalent national scheme. Out of a total of 48 such Institute Programmes in 1965 11 were organised by British scientists, 9 in the U.K., one of them by the Astronomer Royal at Herstmonceux.

Human Sciences Committee

Pending the appointment of the Social Science Research Council the D.S.I.R. Human Sciences Committee was retained to advise Council on research grants in the human sciences. The Committee made its final report to the Council in December, 1965.

In March, 1965, the Committee agreed to the appointment of a Panel to advise on the immediate needs of research into specific problems concerned

with social and human aspects of automation and technological change. This Panel has been active during the year, has undertaken a critical review of research in progress and has conducted three seminars on different aspects of the problem. On the recommendation of the Committee responsibility for the Automation Panel was accepted by the Social Science Research Council early in 1966.

In the year ending October, 1965, the Committee considered fifty new applications for grants, or for extension of grants, amounting to £261,000. Of these, forty-three were approved, amounting to £202,000. One application was transferred to the Ministry of Technology. During the year six universities and other institutions received support from the Committee for the first time.

Fields of research formerly supported by the Human Sciences Committee and now the concern of the University Science and Technology Board are experimental psychology and potential industrial applications of ergonomics and cybernetics.

Atlas Computer Laboratory

The Atlas Computer Laboratory at Chilton exists to provide a powerful computing service primarily for universities, government departments and the research councils. During this year the British-made I.C.T. Atlas Computer was commissioned and completed most of its one-year trial period. By the end of this period it was operating satisfactorily and 90–95 per cent. of its operating time was available for computing work.

At present the universities are taking about half the available time, with the remainder going to the Atomic Energy Authority, the Rutherford Laboratory, certain government departments and the systems and research work of the Laboratory itself. Towards the end of the year over 2,500 jobs a week were being put through the machine.

Systems work has been mainly devoted to developing the Supervisor (the built-in programme which organises the flow of jobs through the machine, including time-sharing and the scheduling of the work for maximum throughput) and various compilers accepted by the machine include Fortran, Algol, Atlas Autocode, Extended Mercury Autocode, Atlas Basic Language, LISP and IPL 5. The work done on the Algol compiler makes it possible for the machine to accept without any change programmes written for the Elliott 803, 503 and 4100 machines, the English Electric KDF. 9 and the I.C.T. 1900 series.

The Laboratory has created five research posts, three of which are held jointly with appointments in universities. The holder of one of these posts is working on some applications of computers to problems in number theory, and another to the study of radiation transfer in planetary atmosphere.

The Laboratory is supporting a number of research projects at universities, ranging from a library of X-ray crystallography programmes to a theoretical study of adaptive control. During the autumn of 1965 members of the Programming Group were invited to America to collaborate with computer

specialists at the Carnegie Institute of Technology on new Supervisor developments for the latter's I.B.M. 360/67 installation. A number of outside lecturers, including visitors from America and from Continental Europe, were invited to give talks in the laboratory on the work they were doing. Fortran courses are being held periodically for the benefit of users. Close contact has been established with the National Computing Centre set up by the Ministry of Technology in Manchester.

ASTRONOMY, SPACE AND RADIO BOARD

At distances beyond 10^{27} cms. at which lie the furthest detected galaxies, we know nothing of the laws of physics or the nature of the Universe. For the study of the behaviour of matter at these great distances, we require large optical and radio telescopes. Herein then lies the special importance of astronomy. In addition to its distinctive role in western culture, it is today one of the main fields of application of physics. Astronomy is overlapping high energy physics in the study of cosmic rays, in gamma and X-ray astronomy, and particularly in the problems posed by the newly-discovered quasi-stellar bodies—quasars. Physics is on the threshhold of far-reaching developments which will come to fruition with a new theory of the nature of matter and of its fundamental reactions. Either at this stage, or the one beyond, gravitation, matter creation and the problems of cosmology are likely to be unified with high energy physics. Taking part in such a synthesis of physical thought represents a great intellectual challenge and makes astronomy one of the most exciting fields of scientific activity.

Astronomy is therefore primarily natural philosophy, and its immediate economic and industrial significance is probably small except in so far as radio telescopes of advanced design are now being applied to satellite telecommunication work, and the need for specialised equipment is a continuing spur to the electronics industry. Astronomy and nuclear physics are, however, of immense importance in that they provide a large number of university teachers in physics and mathematics, and afford a good training ground for young mathematicians and physicists. The by-products of research in the form of trained men move into a number of industries needing automatic computing and control techniques to name but two possible applications.

The case for supporting the U.K. space research programme rests similarly on the contribution it makes to our basic knowledge of astronomy, geophysics and meteorology. On the applied side such research increases our knowledge of the ionosphere and is of value to radio communication and aircraft navigation.

The Astronomy, Space and Radio Board is advised by five committees, three covering the work of the two Royal Observatories and the Radio and Space Research Station and two covering policy and grants in astronomy and space research respectively. With the advice of the two last committees and the Board, the Council supports a wide range of research at universities including radio research, cosmic ray studies and some work of geophysical interest.

Royal Greenwich Observatory

During the year the Royal Greenwich Observatory has finished most of the extensive work which has been undertaken on the Globular Cluster Omega Centauri, using data obtained at the Cape Observatory and at the Radcliffe Observatory, Pretoria, by both Cape and Herstmonceux personnel. This work includes the first demonstration of the rotation of a globular cluster, and a fairly reliable determination of the velocity dispersion, which has been reconciled theoretically with the density distribution. The Astronomer Royal has several times during the year taken a small team from the Observatory to work on the new Egyptian 74-inch telescope at Kottamia in the Suez desert. Co-operative programmes have been arranged with Professor Samaha, Director of the Helwan Observatory. Interest in variable stars has been extended to the Semi-Regular variables, many of whose radial velocities have been secured in Egypt by Herstmonceux and Helwan personnel. As these variables are comparatively bright they are suitable for visual observation; in fact a large number have been observed repeatedly in meridian programmes. The Meridian Department is making a very careful study of the proper motions resulting from transit observations.

The Engineering Department has designed and constructed three spectrographs, one of which is now at the Radcliffe Observatory, Pretoria, for the use of the Cape Observatory. Another of these instruments (the Coude spectrograph of the 30-inch reflector) has been used by Professor J. D. McGee, of the Imperial College, to test image tubes of his own development and manufacture. Preliminary results were promising.

An ICT 1909 computer was installed in the Nautical Almanac Office at the Royal Greenwich Observatory in May 1966. The machine will be used for computing data for the Nautical and Air Almanac and the Astronomical Ephemeris and will also provide a computing service for the benefit of all departments of the Observatory.

The building to house the Isaac Newton Telescope was started during 1965 and is nearing completion. It is expected that the erection of the telescope itself will be completed and it will be ready for preliminary astronomical tests early in 1967, prior to commissioning some months later.

The Royal Observatory, Edinburgh

On July 1st, 1965, the Observatory was honoured by a visit from H.M. the Queen and H.R.H. the Duke of Edinburgh.

Good progress has been made during the past year in astrophysics, astronomical instrumentation, space research and seismology.

In astrophysics interest has been centred on problems of star formation, stellar evolution and the properties of the interstellar medium. Measurements based on observations with the Observatory's Schmidt telescope include a precise determination of the wavelength dependence of obscuration by interstellar particles, which supports the theory that they are composed of graphite; and the discovery of thousands of stars in the very young stellar association Cygnus II, embedded in dense localised obscuring clouds. Other investigations are concerned with rotating stars, element abundances and stellar kinematics.

The observational work of the Observatory is likely to benefit considerably from an observing station at Monte Porzio, south of Rome, with a new Schmidt telescope which is now under construction. The station is being set up in grounds belonging to the Rome University Observatory, whose assistance and co-operation has been extremely valuable.

In the field of astronomical instrumentation, the Observatory has continued to work on the automation of measuring instruments and of control systems for telescopes.

In space research, the first firings have been made from Woomera and Sardinia of rockets containing photometric and spectroscopic instruments for studies of stellar radiation in the ultra-violet.

Systematic tracking of the paths of artificial satellites has continued at the Observatory's outstation at Earlyburn, Peeblesshire, while observations of geodetic satellite Geos I have also been secured with the Observatory's Schmidt telescope. Following plans made with the American Coast and Geodetic Survey, the Observatory's outstation is to become one of the points linking the various geodetic networks which are now being surveyed by means of artificial satellites.

The joint seismology programme of the units of the Observatory and of the University Department of Astronomy has led to the production of a mobile system, recording on magnetic tape, of eighteen seismometers with associated amplifiers, modulators and cable or radio links.

Collaboration with Radcliffe Observatory, South Africa

For a long time the main facility available to British astronomers in the Southern Hemisphere has been the 74-inch telescope at the Radcliffe Observatory in Pretoria, which is owned and managed by the Radcliffe Trustees.

Council is anxious that the excellent facilities at the Radcliffe Observatory shall continue to be used to the limit of their capacity by British astronomers. Accordingly it has entered into negotiations with the Radcliffe Trustees for a closer collaboration in the future use and support of the Observatory. It is hoped that a suitable agreement will be made between Council and the Trustees under which the Radcliffe Observatory will be managed by the S.R.C.

Research Grants for Optical Astronomy

There is considerable U.K. interest in astronomical work in the Mediterranean area. In addition to the observing station at Monte Porzio which is being established by the Royal Observatory, Edinburgh, Council is supporting, by means of a research grant, work on solar magnetic fields at Malta under the direction of Professor R. O. Redman (Cambridge University) at a cost of £24,000 over five years.

Theoretical Astronomy

Consideration has been given in conjunction with the Nuffield Foundation and the Wolfson Trust to a proposal from Professor F. Hoyle, F.R.S., that an Institute of Theoretical Astronomy should be established at Cambridge University. The University has now approved the detailed arrangements for

its establishment as from 1st August, 1966, and the Council has made a grant of £250,000 for the period ending on 1st July, 1972.

The Council has also welcomed plans which have been made by the University of Sussex for modest developments in theoretical astronomy and the association which this will bring between the University and the Royal Greenwich Observatory. A grant of £33,500 has now been made to assist the University in building up a research group in this field headed by a new research professor. In addition the University has appointed the Astronomer Royal and senior members of the Royal Greenwich Observatory staff to honorary posts.

Radio Astronomy

In line with the recommendations of the Fleck Committee, Council has continued its policy of support for radio astronomy research at Cambridge and Manchester Universities by making annual consolidated grants of about £60,000 to each university for the various research programmes using the existing instruments at Lord's Bridge and Jodrell Bank. A number of important results have been obtained at Jodrell Bank during the year particularly the new limits set to the angular diameters of a number of quasars. This experiment was carried out in co-operation with the Royal Radar Establishment at Malvern and the signals from one of the 84 ft. radio telescopes there were conveyed to Jodrell Bank via three radio links and combined with the output of the 250 ft. Mark I telescope to give an interferometer system with a spacing of 600,000 wavelengths at 21 cms. A number of quasars and other radio sources were found to be unresolved, indicating angular diameters of less than one tenth of a second of arc, and thus confirming the impression that the great energy output of these objects must be occurring in an exceedingly small volume of space. Many other measurements of the galactic and extra-galactic radio emissions were carried out by means of the S.R.C. grants, and in the field of space research precise measurements were made of the descent of the Russian Luna 9 on to the lunar surface followed by the reception of the first close-up photographs of the moon obtained by a camera on its surface.

During the year the Mark III radio telescope for the University of Manchester came into operation. This is a 125 ft. transportable instrument which will be used as an interferometer in conjunction with the Mark I and Mark II telescopes, principally to continue the work on the angular diameter and structure of the distant radio sources.

In July, 1965, the Minister of State, Lord Bowden, inaugurated a new radio telescope for research in radio astronomy at Cambridge. This instrument, which cost £550,000, uses the technique of " aerial synthesis " to provide a resolution equivalent to that of a parabolic reflector one mile in diameter. It has been possible for the first time to map the detailed structure of many radio sources, and the results are important in understanding the physical processes occurring both in supernovae and radio galaxies.

In addition to its large resolving power the instrument provides a very great sensitivity, and the combination has made possible the detection of sources some fifty times weaker than those reached in any previous survey. At the same time the positions of even these very faint sources can be

measured with an accuracy of a few seconds of arc, so that a conclusive search may be made for any related optical galaxy or quasar.

Earlier work at Cambridge has shown the importance of observations of distant radio sources in distinguishing between different cosmological theories ; the extension to much fainter sources marks an important step in the exploration of the Universe.

In addition to this work with the new telescope a number of other programmes have been extended. The discovery and study of diffraction phenomena caused by irregularities of electron density in interplanetary space has provided valuable information on the outflow of material from the sun, particularly in regions far from the ecliptic which have not been studied by space-probes ; it has also provided a highly sensitive technique for measuring the angular diameter of radio sources. Measurements of the polarisation and spectrum of galactic radio emission have been continued.

The proposals for new radio telescopes for Cambridge and Manchester Universities, discussed by the Fleck Committee are still under consideration. The studies have now reached a stage where it is hoped to go forward with proposals for the basic design studies in the near future.

Cosmic Ray Studies

The construction of the large detecting array at Haverah Park, for which a grant of £110,500 was made to Professor J. G. Wilson (Leeds University) in 1964, is now well advanced. The programme is a co-operative one between Durham and Leeds Universities and Imperial College, London, and each has continued to make full use of the existing smaller array at Haverah Park. Several grants have been made for these programmes including one of £9,000 to Dr. H. R. Allan (Imperial College) for the study of radio pulses from extensive air showers. The emission of such pulses by cosmic ray showers has been demonstrated recently at Jodrell Bank and Dr. Allan will operate a small radio receiving system in conjunction with the detecting array at Haverah Park.

SPACE RESEARCH

The programme of scientific space research which Council is sponsoring includes the use of near-earth satellites as well as various types of sounding rockets. It will, in due course, be extended by the use of space probes. Such vehicles are made available to U.K. scientists through the national programme of sounding rockets and also through international co-operation, principally with the United States National Aeronautics and Space Administration (N.A.S.A.) and the European Space Research Organisation (E.S.R.O.).

The Space Policy and Grants Committtee is responsible to the Council for the formulation of a research programme, the general management of which is carried out by the Space Research Management Unit (S.R.M.U.) which is part of the Astronomy, Space and Radio Division.

There are some thirty-four space research groups. The majority of these are in the universities and they are largely supported by S.R.C. grants. There are also space research groups at the Radio and Space Research Station, the

Royal Observatory, Edinburgh and in other government establishments. The main fields of interest in the scientific programme concern the neutral atmosphere, the ionosphere, solar radiation, energetic particles, magnetic fields, astronomy and the inter-planetary medium. Associated activities include tracking of satellites, data acquisition and handling, and orbital studies.

The national sounding rocket programme, managed by the S.R.M.U., uses Skylark rockets which are launched at Woomera, South Australia, by the Australian Weapons Research Establishment. During the past year some twenty rockets have been launched each containing three or four experiments. A Skylark rocket with an attitude stabilised head has recently been developed and the six launched to date have all been successful. From them some particularly interesting data has been obtained on the chromospheric and coronal ultra-violet spectrum of the sun. The development of a smaller rocket, known as Petrel, is in progress. This is expected to be particularly suitable for synoptic aeronomy and ionospheric studies from launching sites both in the U.K. and abroad.

Under the co-operative programme with the United States preparation of the U.K.-3 satellite has continued. Council is sponsoring this project and the S.R.M.U. are responsible for the scientific management and co-ordination of the payload. The experiments are being provided by five research groups and the satellite itself is being built in this country under the supervision of the Ministry of Aviation. It will be launched by N.A.S.A. from an American Range in 1967.

Another aspect of U.K.-U.S. co-operation is the inclusion of U.K. experiments in the N.A.S.A. satellite programme. Some ten experiments have now been accepted and two were contained in satellites launched during the year.

European Space Research Organisation

U.K. scientific interests in E.S.R.O. are subject to review by the Space Policy and Grants Committee of the S.R.C. During the year there were four launchings from the Sardinia Range of sounding rockets carrying U.K. experiments. The increased schedule of launchings for 1966 from ranges in Norway, Greece and Sweden, as well as Sardinia, will include forty experiments from U.K. groups. No satellites have yet been launched by E.S.R.O. but the payloads of the five now in preparation include seventeen experiments from U.K. scientists. In addition to participating in the programmes, U.K. scientists take an active part in the work of the E.S.R.O. advisory groups.

The Radio and Space Research Station

The work of the Station continues to be concerned with the study of radio wave propagation with the object of building up a fund of basic knowledge covering the whole field, for the benefit of engineers and others making practical use of radio waves. About one half of its total effort is now devoted to space research, divided between research aimed at providing knowledge which has a direct bearing on the radio wave propagation programme, and the provision of services to space research workers.

Investigations of practical interest to communications continue. A typical example is a study of the field strength produced at a distance by an H.F.

transmitter of known characteristics in order to determine whether a more accurate method of prediction of the field at any distance can be devised.

Another investigation, being carried out in co-operation with other organisations using HF communications, is a study of the practical value of oblique incidence ionosondes for determining the optimum frequency for communication over a given path at any time. The path United Kingdom-Aden is being studied and preparations for the observational programme are well advanced.

Further measurements of the field strength of VHF signals at Cirencester produced by transmitters in East Anglia have been made and studied in conjunction with meterological data measured along the same path. The ultimate object of this study is to provide a method of predicting the field strength set up by a VHF transmitter at distances at which it is governed in an important way by the state of the troposphere.

The facilities operated by R.S.R.S. at the N.A.S.A. Satellite Tracking and Data Acquisition Network Station at Winkfield, Berks., have been considerably extended by the provision of additional receiving, recording and aerial equipment so that telemetry operations on two satellites are now possible simultaneously.

The 85 ft. steerable radio telescope at Chilbolton, Hants., is now complete and it will soon be commissioned. Among the several investigations planned with the telescope is a study of propagation through the troposphere at very low angles of elevation. This work is of particular importance to the Post Office in connection with satellite communications systems when a satellite is just above the horizon.

Work continues on the preparation of the experiments to be flown by the Station in the satellites U.K.-3 and ESRO.I. The U.K.-3 experiment will measure the distribution over the earth of noise originating from lightning discharges on two frequencies in the HF band. It will also measure the fluxes and energy spectra of charged particles which may give rise to aurorae and ionospheric disturbances at high latitudes.

At the request of E.S.R.O. a satellite telemetry receiving station is being built in the Falkland Islands to be operated on an agency basis by the Station.

Wolfe Award 1966

The Council noted with pleasure that this year's Wolfe Award for the research worker considered to have made the most outstanding contribution to the work of the Establishments administered by the former D.S.I.R. was awarded to Dr. J. W. King of the Radio and Space Research Station for his work on the analysis of results of topside sounding of the ionosphere.

NUCLEAR PHYSICS BOARD

The field of responsibility of the Nuclear Physics Board may be broadly divided into two principal parts:—

(*a*) studies of the structure of the atomic nuclei to provide a detailed understanding of the way they are built up of neutrons and protons —nuclear structure physics ; and

(*b*) the physics of the elementary particles—particle physics—which is concerned with the wide-range of sub-nuclear particles discovered in the past twenty, and especially in the last five years.

This latter study involves our deepest penetration into the structure of the material universe and is concerned to establish the detailed properties of the sub-nuclear particles, the mesons, hyperons, etc., the way they interact with one another, and the significance of the regularities thus found. The present situation in the subject may be likened to that which followed the discovery, a hundred years ago, of the Periodic Classification of the chemical elements, before the regularities were explained in terms of the electronic structure of the extra-nuclear part of atoms.

Because of the unity of the field for which it is responsible, the Nuclear Physics Board, which meets at monthly intervals, has been able to work without establishing Committees. Two Board members give special attention to each of its three main interests, viz.—grants to universities, the Rutherford and Daresbury Laboratories, and support for C.E.R.N.

Nuclear Physics Research Grants

Some of the facilities provided at universities for research into the structure of the atomic nuclei are on a larger scale than those required for research in most other subjects. When the S.R.C. was formed, accelerators of various kinds, provided under earlier D.S.I.R. major grants, were in operation at Birmingham, Glasgow, Liverpool, Manchester and Oxford Universities. In addition construction of two further major machines, a 100 MeV electron linear accelerator at Glasgow, and a 20 MeV electrostatic generator at Oxford, was in progress, the design and construction of a major part of the latter machine being the responsibility of the Rutherford Laboratory. Both of these projects have now been completed. Future needs for nuclear structure research are under review, but at present no major projects are in hand.

Whilst experiments on nuclear structure may still be carried out with accelerators of modest energy within a university laboratory, particle physics requires great accelerators which can only be provided through national or international co-operation. Such for example, are the 28 GeV proton accelerator at the European Centre for Nuclear Physics at Geneva, the U.K. 7 GeV proton synchrotron NIMROD at the Rutherford Laboratory and the 4 GeV electron accelerator NINA, shortly to come into operation at Daresbury. The use of the machines by university physicists is supported by the S.R.C. in various ways.

One way is the provision of instruments and staff for analysing the photographs of the tracks of " elementary particles " generated by the great accelerators and recorded in large bubble-chambers. A bubble-chamber is essentially an instrument for making manifest the trajectories of particles which have passed through it. It is filled with a liquid which is suddenly, and for a very short time of the order of milli-seconds, made sensitive by a sudden temporary reduction of the pressure upon it. If it is in this condition when charged particles are passed through it, small bubbles form along the path and may be recorded by flash-photography. Modern bubble-chambers may contain liquid hydrogen, a heavy hydrocarbon or

other liquid and they may have dimensions of several metres. The tracks produced by the collision with nuclei of particles of different types as they traverse the liquid in the chamber are photographed and the resulting film is supplied to university and other laboratories for detailed analysis. The measurements are made by means of measuring devices which permit the analysis of large numbers of collisions of different types, and this allows the accumulation of results of the necessary statistical weight.

A comprehensive review of university proposals for the analysis of bubble-chamber photographs was carried out by the Board during the summer and autumn of 1965. The film comes principally from experiments made with the C.E.R.N. 28 GeV proton synchrotron and from the 7 GeV proton synchrotron NIMROD, at the Rutherford Laboratory. The U.K., for example, received nearly half a million photographs from C.E.R.N. during the year. The university groups concerned share in the design of the experiment, the photographs being divided between them and the results are often published jointly. The interactions of elementary particles are complicated, and very large numbers of photographs have to be measured and analysed to yield useful statistical information. In general, the photographs show many particle tracks in addition to those which correspond to the types of interaction under investigation in any particular experiment. The tracks corresponding to the significant events may be identified by a human scanner equipped with special viewing and measuring machines, where the detailed trajectories corresponding to the tracks may be measured and recorded in a digital code. Such manual film measuring equipment, some of it very elaborate and sophisticated, is now available in several universities. But the large numbers of photographs now being measured, approaching some millions every year, call for even more rapid methods. Computer controlled measuring systems have therefore been authorised for use at Glasgow and Oxford Universities, Imperial College, London, and at the Rutherford Laboratory. Some of these systems should also be capable of automatically distinguishing and measuring tracks of a prescribed kind from among all the other tracks on a film.

The universities also take part in the design and construction of equipment for experiments in conjunction with the great national and international accelerators which involve other techniques of detecting particles such as spark-chambers and scintillation counters.

Other subjects supported by grants under the nuclear physics budget include theoretical studies and research on cosmic radiation. Among the cosmic rays there are particles with much higher energies than any which can be produced in any accelerator at present considered. Many of the early discoveries in high energy physics were made by studying the interactions of such particles with atomic nuclei; and although the flux of particles is very low, significant experiments with particles of extreme energy are still being made.

The Rutherford Laboratory

The principal purpose of the Rutherford Laboratory is to serve as a national centre in particle physics for the support of experimental and theoretical groups in the universities as well as some of its own physics staff. A

successful and intimate connection between the Laboratory and the universities has already been established and is crucial for the success of the whole enterprise. The experimental programme round the machines is, for example, decided by a small committee in which the universities are very strongly represented.

Through NIMROD, and a smaller accelerator, the 50 MeV proton linear accelerator (the P.L.A.), the Rutherford Laboratory provides an impressive modern national research establishment which universities can use almost as though it were part of their own physics department. NIMROD was in successful operation until February, 1965, when the rotor of one of the large alternators of the power supply to the magnet suffered a mechanical breakdown, fortunately without damage to other equipment or injury to personnel. Both alternators had be rebuilt by the makers with re-designed rotors, and were returned to service in January, 1966. Meanwhile it was possible to operate NIMROD at 2 GeV under improvised arrangements. Some experiments were continued at this energy, while time was made available for increasing the intensity of the proton beam. NIMROD is now regularly accelerating $1{\cdot}2 \times 10^{12}$ protons per pulse to 7 GeV at a rate of 23 pulses per minute. During the breakdown, the Director General of C.E.R.N. very kindly arranged for two of the most urgent experiments on the NIMROD programme to be transferred to the C.E.R.N. proton synchrotron.

Nine teams, consisting of physicists from nine university departments, the Atomic Energy Research Establishment, Harwell, and the Rutherford Laboratory, now have counter experiments either in progress around NIMROD or accepted for its programme. In addition a programme of bubble-chamber experiments is now starting. The French 80 cm. hydrogen bubble-chamber has been in operation at NIMROD since January, 1965, the collaboration involving teams from the French laboratory at Saclay. In addition, the 1·5 metre, heavy liquid bubble-chamber, constructed under the direction of a team from University College, London, was commissioned in December, 1965, whilst the 1·5 metre British national hydrogen bubble-chamber, which has been in use at C.E.R.N., is being re-assembled in the Rutherford Laboratory. The helium bubble-chamber, the responsibility of an Oxford University group, is also nearing completion.

The P.L.A. which produces 50 MeV protons and which has special advantages in its field including a very good polarised proton source, continues to be very heavily exploited for investigations in nuclear structure. In ten months between annual shutdowns for overhaul a good beam was available for experiments for 4,455 hours. Teams from eight university departments, the A.E.R.E., Harwell, as well as from the Laboratory, are at present using the P.L.A. As is the case with experiments around NIMROD the Laboratory physicists are working with the university teams to ensure the maximum use of the facilities.

A team from the Laboratory has been responsible for the design and construction of the 8–10 MeV vertical generator, one of the two major components of the 20 MeV electrostatic generator for Oxford University, and for the assembly of the whole machine. The project was completed in March 1966. Another group has been responsible for the design and construction of another advanced accelerator—the 70 MeV variable energy cyclotron for the A.E.R.E., Harwell.

Since NIMROD was first scheduled in February, 1964, eighteen experiments have been accepted for the experimental programme. Ten have been completed and the remainder form the basis of the programme during 1966.

The Daresbury Nuclear Physics Laboratory.

Construction of the 4 GeV electron synchroton, NINA, to be used mainly, but not exclusively by teams from Northern universities, began in 1963. By March, 1966, the remaining design and construction problems had been solved, major components installed, and the final stage of assembly begun, so that experiments are expected to commence in the autumn of 1966.

European Organisation for Nuclear Research—C.E.R.N.

The European Nuclear Research Centre, C.E.R.N., at Geneva, operates the 28 GeV proton synchrotron, one of the two most powerful particle accelerators in the world, and a 600 MeV synchro-cyclotron. The United Kingdom is one of thirteen Member States that share costs in proportion to their gross national product, the U.K. share of the total being at present about 22 per cent. British physicists participate in the research based upon the C.E.R.N. accelerators either by joining the staff, by proposing experiments for the C.E.R.N. programme, or by going there to work in experimental teams. The Council is responsible for U.K. representation in the governing organs of C.E.R.N.

In December, 1965, the C.E.R.N. Council approved a major new project: the construction of intersecting storage rings for 28 GeV protons. Protons from the synchrotron will be fed into these rings, building up a circulating beam many times more intense than that available in the synchrotron, and this will make possible important experiments with a radically new technique. In addition, the two storage rings will be concentric but not quite circular, intersecting one another at a few points and so arranged that the protons in one circulate in the opposite direction from those in the other. It will thus be possible to study the interactions of pairs of 28 GeV protons colliding head-on with one another ; and it is reasonable to expect that entirely new phenomena will be observed. To obtain equivalent proton-proton collisions by conventional methods in which protons are made to bombard a stationary target containing hydrogen would, because of relativistic effects, require a proton beam with an energy 1700 GeV. Studies of the results of such collisions cannot be made with present accelerators, nor by cosmic rays because of the extremely low intensity of high energy cosmic radiation. The ISR project may make possible a first look into a new world of physics.

Proposal for 300 GeV European Accelerator

The next step in particle accelerator construction beyond the present proton synchrotrons at C.E.R.N. and at Brookhaven in the U.S.A., and the 70 GeV proton synchrotron under construction of Serpukhov in the U.S.S.R., has been under consideration both in Europe and in the U.S.A., for several years. After exploration of the possibilities of world-wide collaboration, a proposal for a 300 GeV European accelerator has been developed by a small group at C.E.R.N. No commitment to such a scheme has yet been entered into by European states, but there has been a small expenditure by the C.E.R.N. group on preparatory work. A design study has been prepared,

site requirements specified and possible sites proposed by several governments. The British Government have, without commitment, proposed a possible site near Mundford in Norfolk.

The Rutherford Laboratory is in high international standing; and through it, and through C.E.R.N., British laboratories and the universities are making substantial contributions to the physics of elementary particles, one of the most sophisticated and demanding of scientific disciplines. The subject is breaking through into a new stratum of the structure of matter. It is reasonable to expect that, as always in the past, such advances will be accompanied by radically new contributions to techniques and in the realm of ideas, of decisive importance in the long term for all science and industry.

HONOURS

Her Majesty has been graciously pleased to confer honours on the following members of the Council and staff:

Birthday Honours 1965

C.B. Mr. J. A. Ratcliffe, C.B.E., F.R.S.
Director of Radio and Space Research Station.

New Year Honours 1966

C.B.E. Professor H. A. Brück, D.Phil., Ph.D.
Astronomer Royal for Scotland, Regius Professor of Astronomy, University of Edinburgh.

Dr. M. R. Gavin
(Principal, Chelsea College of Technology and member of the Research Council).

O.B.E. Mr. P. Bowles,
Chief Engineer, Rutherford High Energy Laboratory.

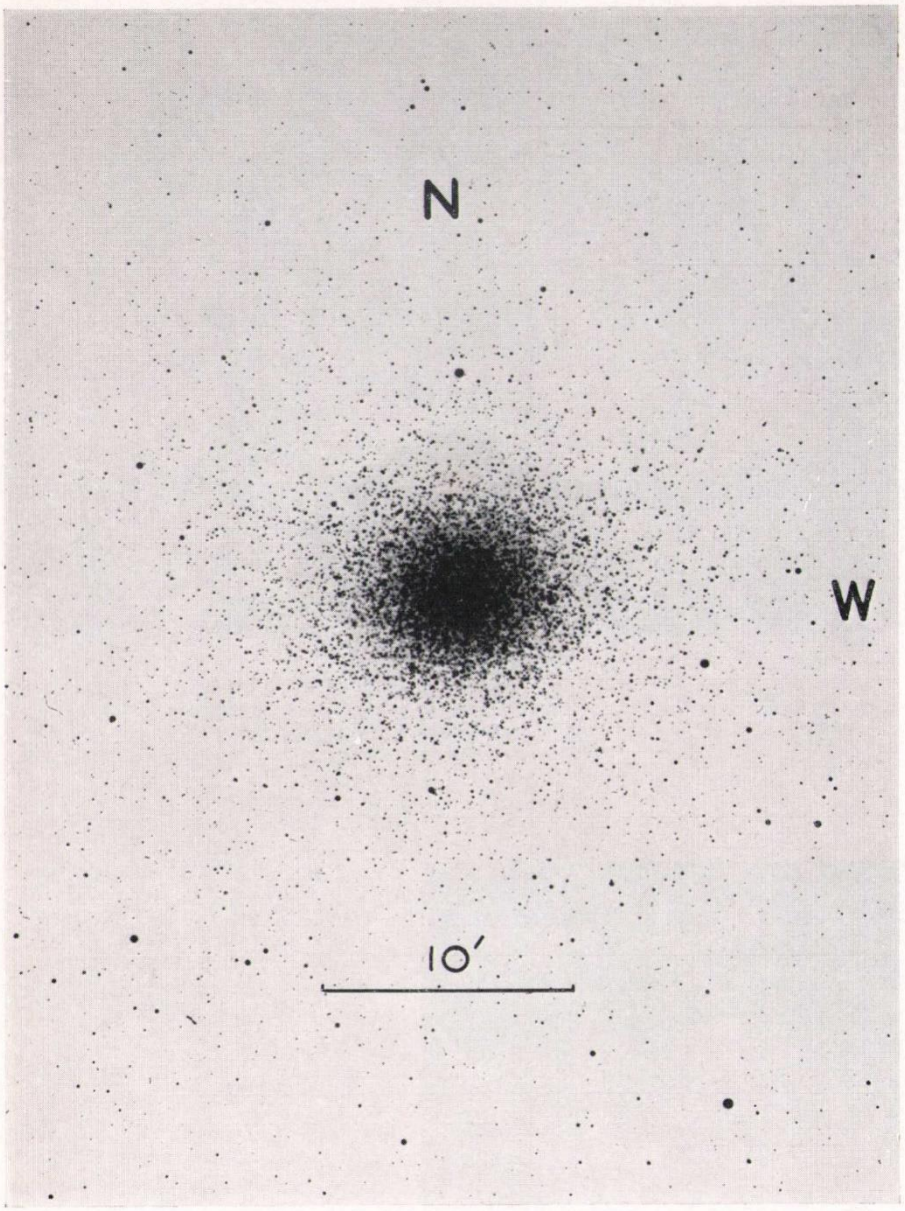
M.B.E. Mr. A. G. Wilson,
Radio and Space Research Station.

B.E.M. Mr. B. F. Offen,
Royal Observatory, Cape of Good Hope.

Mr. J. A. Macken,
Rutherford High Energy Laboratory.

STAFF

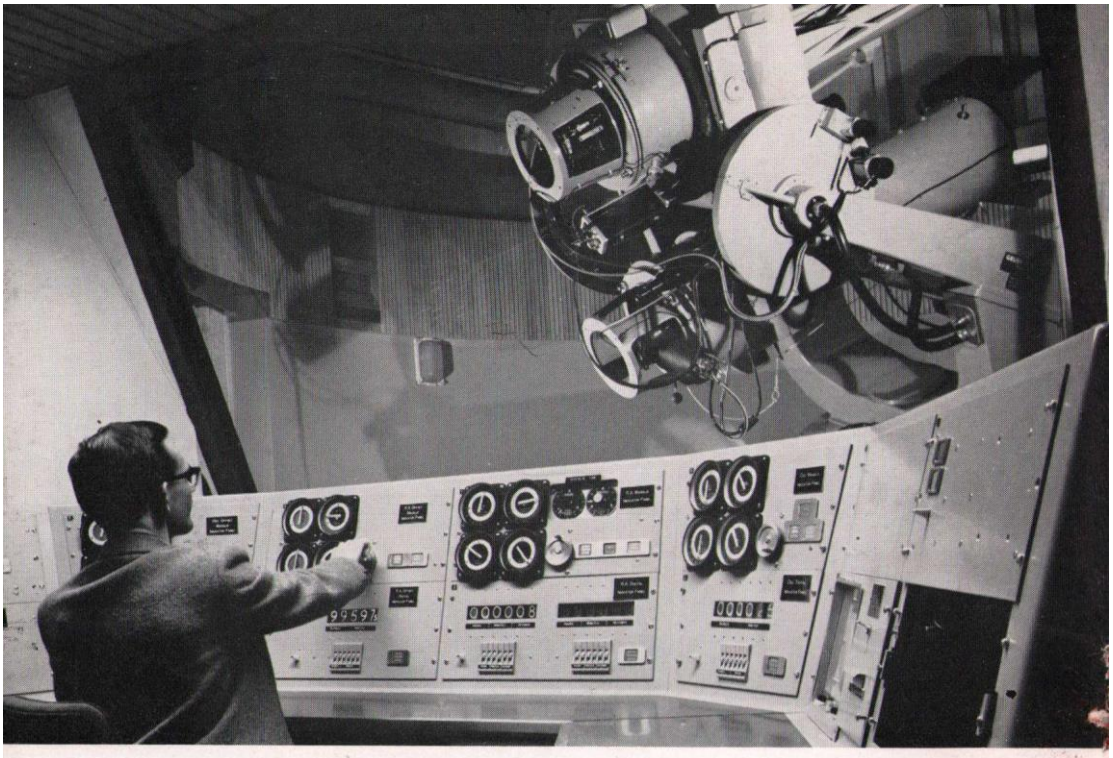
On 31st March 1966 the staff numbered 2,241; including 767 scientific and professional engineering staff and 293 technical staff.



The Globular Cluster Omega Centauri
from a photograph taken with the 24-inch refractor at the Cape Observatory

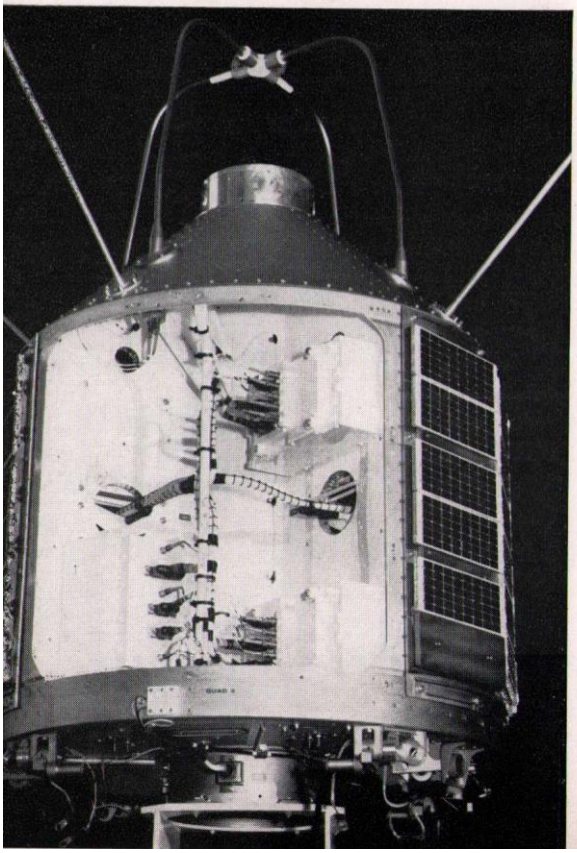
Exposure: 30 minutes
Emulsion: Kodak 103a–0 + GG13 filter

Positions, magnitudes and colours measured for more than 6500 stars in this field, and motions measured for more than 4,500, have been used in an exhaustive study of the clusters at the Royal Greenwich Observatory, Herstmonceux



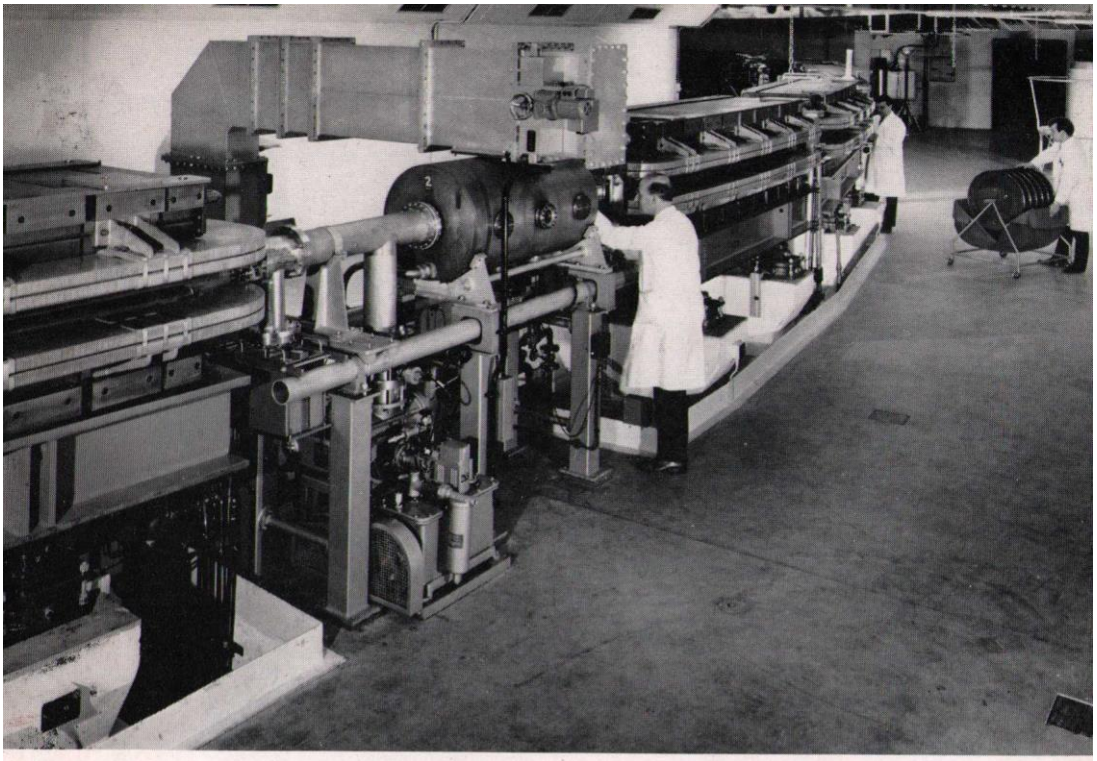
Royal Observatory, Edinburgh

Twin sixteen inch telescopes at the Royal Observatory, Edinburgh, seen from the control room. The telescopes, operated in this way by remote control, are bringing automation to optical astronomy



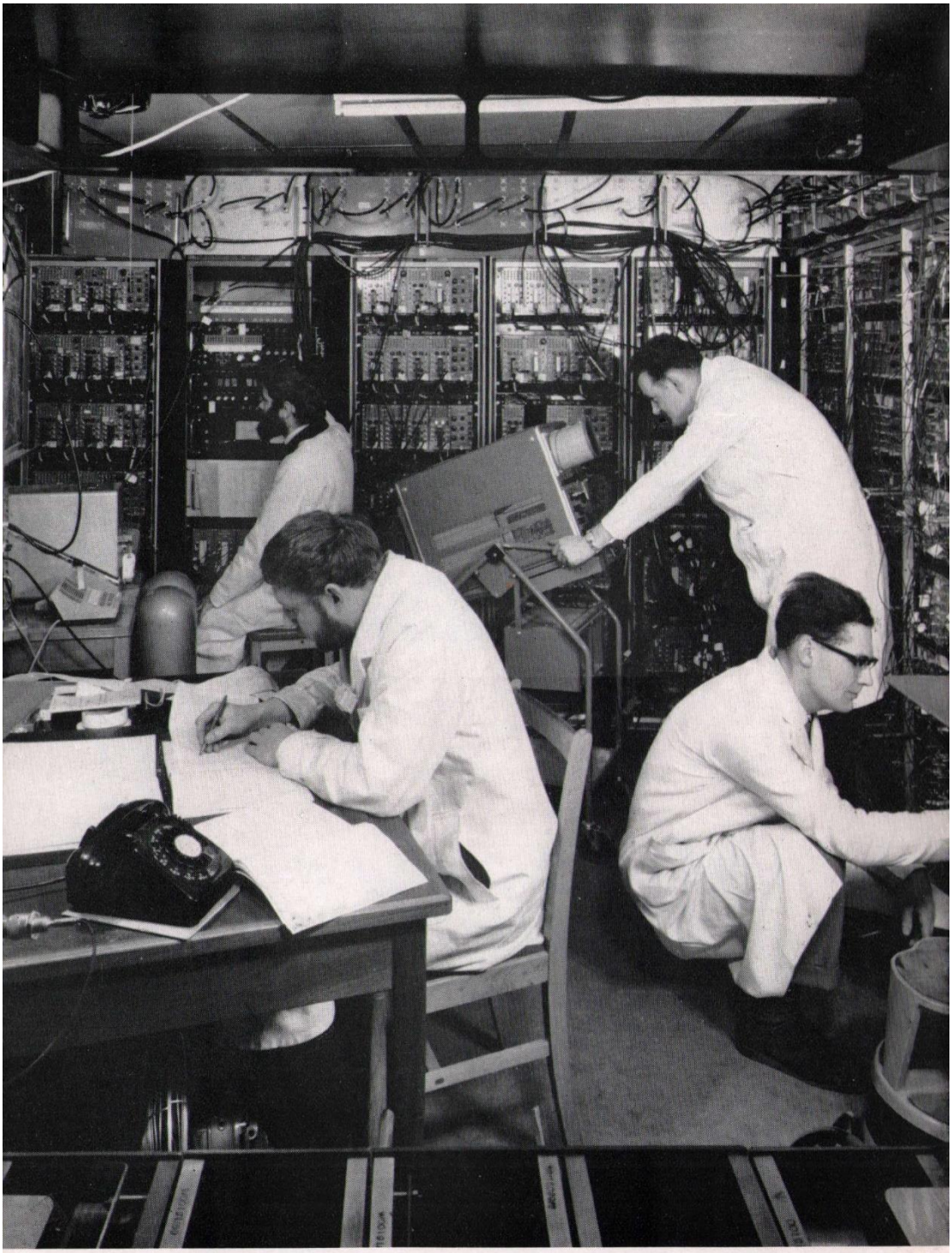
Radio and Space Research Station
U.K.–3 satellite showing compartment containing apparatus for the experiment of the Radio and Space Research Station

Atlas Computer Laboratory
A section of the upper floor of the computer block showing input and output equipment and some of the magnetic tape decks



Daresbury Nuclear Physics Laboratory

Picture shows the installation of the magnetic ring of NINA the 4GeV electron synchrotron nearing completion at the Daresbury Nuclear Physics Laboratory



K6 Local Control Room at the Rutherford High Energy Laboratory

APPENDIX I

THE ROYAL CHARTER OF THE SCIENCE RESEARCH COUNCIL

ELIZABETH THE SECOND by the Grace of God of the United Kingdom of Great Britain and Northern Ireland and of Our other Realms and Territories Queen, Head of the Commonwealth, Defender of the Faith:

TO ALL TO WHOM THESE PRESENTS SHALL COME, GREETING!

WHEREAS Our Secretary of State has appointed certain persons to be the Chairman and the other members of a Council for promoting and supporting research in science and technology and related matters to be known as the Science Research Council:

AND WHEREAS it has been represented unto Us that for the purpose of carrying out the objects of the said Council and with a view to facilitating the holding of and dealing with property and to encouraging the making of gifts and bequests in aid of the said objects it is expedient that the said Council should be incorporated:

NOW, THEREFORE, KNOW YE that We, by virtue of Our Prerogative Royal and of all other powers enabling Us in that behalf, of Our especial grace, certain knowledge and mere motion have granted and declared and do by these Presents for Us, Our Heirs and Successors, grant and declare as follows:

1. The persons now the Chairman and other members of the Science Research Council aforesaid (whose names are set out in the Schedule hereto), and all such other persons as may hereafter become the Chairman and other members of the body corporate hereby constituted, shall for ever hereafter (so long as they continue to be members of the Council) be one Body Corporate under the name of "The Science Research Council" (hereinafter referred to as "the Council"), and by the same name shall have perpetual succession and a Common Seal, with power to break, alter and make anew the said Seal from time to time at their will and pleasure and by the same name shall and may sue and be sued in all courts and in all manner of actions and suits, and shall have power to enter into contracts, to acquire, hold and dispose of property of any kind, to accept trusts and generally to do all matters and things incidental or appertaining to a Body Corporate.

2.—(1) The objects for which the Council are established and incorporated are as follows:

(*a*) To carry out research and development in science and technology.

(*b*) To encourage and support by any means research and development in science and technology by any other person or body.

(*c*) Without prejudice to the foregoing paragraph, to provide and operate equipment or other facilities for common use in research and development in science and technology by universities, technical colleges or other institutions or persons engaged in research.

(*d*) To make grants for post graduate instruction in science and technlogy.

(*e*) To disseminate knowledge concerning science and technology.

(2) The Council may pursue their objects in Our United Kingdom of Great Britain and Northern Ireland or elsewhere.

3. All moneys and property howsoever received by the Council, including any moneys voted by Parliament, shall be applied solely towards the promotion of the objects of the Council and no portion thereof (except as otherwise provided in this Our Charter) shall be paid or transferred directly or indirectly to the members thereof.

4.—(1) The Council shall consist of a Chairman and not more than fifteen nor less than ten other members.

(2) The Chairman and other members shall be appointed, and the terms of their appointment shall be determined, by Our Secretary of State, who shall appoint not less than two-thirds of the total number of members for the time being on account of their qualifications in science or technology.

(3) Before appointing any member on account of his qualifications in science or technology Our Secretary of State shall consult the President for the time being of the Royal Society.

(4) Every member shall hold and vacate his office in accordance with the terms of his appointment and shall, on ceasing to be a member, be eligible for re-appointment but

(*a*) a member shall not be appointed for a term of more than four years;

(*b*) a member, other than the Chairman, who at any time serves for eight consecutive years shall not be eligible for re-appointment before the expiration of one year from the end of that period; and

(*c*) a member may at any time by notice in writing to Our Secretary of State resign his office.

(5) Except as provided in paragraph (7) of this Article, the Council shall, in the case of any such member as Our Secretary of State, with the approval of the Lords Commissioners of Our Treasury, may determine

(*a*) pay to him such remuneration and allowances as may be so determined in his case; and

(*b*) pay to or in respect of him, such pension, allowance or gratuity on his retirement or death, or make such payments towards provision for such a pension, allowance or gratuity, as may be so determined in his case.

(6) If a person ceases to be a member of the Council otherwise than on the expiration of his term of office, and it appears to Our Secretary of State that there are special circumstances which make it right that that person should receive compensation, the Council shall make to that person a payment of such amount as Our Secretary of State may, with the approval of the Lords Commissioners of Our Treasury, determine.

(7) The Council shall not in any circumstances or at any time make to or in respect of any person in his capacity as a member of the Council any payment of any kind whatsoever for or in respect of any period when he is also a member of Our Commons House of Parliament, other than a payment by way of reimbursement to him of actual out of pocket expenses previously and necessarily incurred by him in the performance of his duties as such member of the Council.

5.—(1) The Council may act notwithstanding a vacancy among the members thereof and the validity of any proceedings of the Council shall not be affected by any defect in the appointment of a member thereof.

(2) The quorum of the Council shall be six members personally present or such greater number as the Council may from time to time determine.

6. Subject to the provisions of this Our Charter, the Council may regulate their own procedure.

7.—(1) The Council may appoint committees to exercise, or advise them on the exercise of, any of their functions and may

(*a*) appoint to any such committee persons who are not members of the Council; and

(*b*) at any time revoke the appointment of any member of any such committee.

(2) Where the Council appoint to any such committee any person who is not a member of the Council, they shall, if Our Secretary of State, with the approval of the Lords Commissioners of Our Treasury, so determines, pay to that person such remuneration and allowances as may be so determined in his case, but Article 4(7) above shall apply as regards payment to any such person as though he were a member of the Council.

8.—(1) The Council shall, with the approval of Our Secretary of State, appoint a Secretary and may appoint such other officers and take into their employment such other persons as the Council may determine subject, as to the number of such officers and other persons, to the approval of Our Secretary of State and the Lords Commissioners of Our Treasury.

(2) The Council may

(*a*) pay to their Secretary and to their other officers and to other persons employed by them such remuneration as the Council may, with the approval of Our Secretary of State and the Lords Commissioners of Our Treasury, from time to time determine ; and

(*b*) as regards any officers or other persons employed in whose case it may be determined by the Council, with the approval of Our Secretary of State and the Lords Commissioners of Our Treasury, so to do, pay to or in respect of them such pensions (including gratuities), or provide and maintain for them such pension schemes (whether contributory or not), as may be so determined.

(3) Where the holder of an office or employment with the Council, being a participant in any pension scheme applicable to the office or employment, becomes a member of the Council, he may be treated for the purposes of the pension scheme as if his service as a member of the Council were service in an office, or employment with the Council, and his rights under the scheme shall not be affected by any provision of this Our Charter which requires that pensions, allowances or gratuities or payments towards the provision of them payable in the case of members of the Council shall be determined by Our Secretary of State with the approval of the Lords Commissioners of Our Treasury.

9. The application of the Seal of the Council shall be authenticated by the signatures of the Chairman or of some other member of the Council authorised generally or specially by the Council to act for that purpose, and of one of such officers of the Council as may be so authorised by the Council so to act.

10. The Council may by resolution in that behalf passed at a meeting of the Council by a majority of not less than three-quarters of the members present and voting (being an absolute majority of the whole number of the members of the Council) and confirmed at a further meeting of the Council held not less than one month nor more than four months afterwards by a like majority, add to or amend this Our Charter, and such addition or amendment, when allowed by Us, Our Heirs or Successors in Council, shall become effectual, so that this Our Charter shall thenceforward continue and operate as though it had been originally granted and made accordingly: and this provision shall apply to this Our Charter, as added to or amended in manner aforesaid.

11. In this Our Charter " science " includes the social sciences and references to Our Secretary of State are to Our Secretary of State for Education and Science.

IN WITNESS whereof We have caused these Our Letters to be made Patent.

WITNESS Ourself at Westminster the first day of April in the fourteenth year of our Reign.

BY WARRANT UNDER THE QUEEN'S SIGN MANUAL

APPENDIX II

MEMBERS AND ASSESSORS OF BOARDS AND COMMITTEES

UNIVERSITY SCIENCE AND TECHNOLOGY BOARD

All appointed (unless otherwise indicated) 1/9/65

Professor Sir Ewart Jones, D.Sc., Ph.D., M.A., F.R.I.C., F.R.S. (*Chairman*).
Professor B. Bleaney, C.B.E., M.A., D.Phil., F.R.S.
Professor R. Brown, Ph.D., D.Sc., F.R.S.
A. Caress, B.A., Ph.D.
Professor G. C. Drew, M.A.
H. M. Finniston, B.Sc., Ph.D., F.I.M.
Professor H. Ford, D.Sc.(Eng.), Ph.D., M.I.Mech.E., M.Inst.C.E.
M. R. Gavin, C.B.E., M.A., D.Sc., F.Inst.P.
The Rt. Hon. the Earl of Halsbury.
Brynmor Jones, D.Sc., Ph.D., F.R.I.C.
J. W. Menter, M.A., Sc.D., F.Inst.P.
Professor R. S. Nyholm, D.Sc., F.R.I.C., F.R.S.
Professor G. Porter, B.Sc., M.A., Ph.D., Sc.D., F.R.I.C., F.R.S.
Professor E. J. Richards, O.B.E., M.A., D.Sc., F.R.Ae.S.
Professor A. L. Roberts, Ph.D., F.R.I.C.
J. E. Smith, Sc.D., Ph.D., F.R.S.
Professor I. N. Sneddon, M.A., D.Sc.
Sir Peter Venables, Ph.D., F.R.I.C.

ASSESSORS:

University Grants Committee—R. C. Griffiths.
Ministry of Technology—J. Knox, M.A.
Dept. of Education & Science—C. Freedman.

Secretary: L. S. Smith, M.A.

COMMITTEES OF THE UNIVERSITY SCIENCE AND TECHNOLOGY BOARD

Aeronautical and Civil Engineering Committee

Professor E. J. Richards, O.B.E., M.A., D.Sc., F.R.Ae.S. (*Chairman*).
F. W. Gifford, B.Sc.Eng., Ph.D., D.I.C., M.I.C.E., M.I.Struct.E.
Professor M. R. Horne, M.A., M.Sc., Ph.D., Sc.D., M.I.C.E., A.M.I.Struct.F
D. J. Lyons, B.Sc., F.R.Ae.S., M.Inst.N.E.
Professor J. B. B. Owen, D.Sc., F.R.Ae.S.
W. J. Reiners, B.Sc.
F. G. Thomas, B.Sc., Ph.D., M.I.C.E., M.I.Struct.E.
C. T. Wyatt, B.Sc.Eng., D.I.C., M.I.C.E., M.I.Struct.E.
Professor A. D. Young, O.B.E., M.A., F.R.Ae.S., A.F.I.A.S.

ASSESSOR:

Ministry of Technology—A. B. Hammond, B.Sc., Ph.D., A.R.C.S., F.P.S., A.Inst.P.

Secretary: H. J. Ivey, B.Sc., Ph.D.

Biology Committee

Professor R. Brown, Ph.D., D.Sc., F.R.S. (*Chairman*).
Professor S. R. Elsden, B.A., Ph.D.
Professor J. Heslop-Harrison, Ph.D., D.Sc., F.L.S.
Professor Bryn Jones, D.Sc., B.Sc.
Professor H. Kay, M.A., Ph.D.
Professor H. L. Kornberg, B.Sc., M.A., Ph.D., D.Sc., F.R.S.
T. F. McCrae, O.B.E., D.Sc., L.L.D., F.R.I.C.

Professor R. A. Morton, Ph.D., D.Sc., F.R.I.C., F.R.S.
J. M. Shewan, B.Sc., Ph.D., F.R.I.C., F.R.S.E.
Professor J. Z. Young, M.A., D.Sc., F.R.S.

ASSESSORS:

Agricultural Research Council—D. L. Gunn, C.B.E., D.Sc.
Medical Research Council—P. J. Chapman, M.D.

Secretary: J. F. A. Thomas, B.Sc.

Chemical Engineering and Technology Committee

Professor A. L. Roberts, B.Sc., Ph.D., F.R.I.C. (*Chairman*).
J. W. Barrett, B.Sc., Ph.D., A.R.C.S., D.I.C., F.R.I.C., M.I.Chem.E.
R. L. Brown, M.A., F.Inst.P., M.I.Chem.E.
Professor K. G. Denbigh, M.A., Ph.D., D.Sc., F.R.I.C., F.R.S.
C. C. Hall, B.Sc., M.Sc., Ph.D., F.R.I.C., F.Inst.P.
Professor F. Morton, M.Sc.(Tech.), Ph.D., D.Sc., F.R.I.C., M.I.Chem.E.
Professor A. W. Scott, C.B.E., Ph.D., M.I.Mech.E., M.I.Chem.E.
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W. F. Watson, Ph.D., D.Sc., F.I.R.I.
M. Zvegintzov, B.Sc., M.A.

ASSESSOR:

Ministry of Technology—D. Neville-Jones, M.A.

Secretary: W. G. Potter, B.Sc., Ph.D.

Chemistry Committee

Professor R. S. Nyholm, D.Sc., F.R.I.C., F.R.S. (*Chairman*).
Professor D. H. R. Barton, D.Sc., F.R.S.
Professor T. L. Cottrell, D.Sc.
D. S. Davies, M.A., D.Phil.
Professor C. Eaborn, Ph.D., D.Sc., F.R.I.C.
B. A. Hems, D.Sc., F.R.I.C.
Professor G. W. Kenner, Ph.D., Sc.D.
Professor G. Porter, B.Sc., M.A., Ph.D., Sc.D., F.R.I.C., F.R.S.
Professor J. E. Salmon, Ph.D., F.R.I.C.
Professor N. Sheppard, M.A., Ph.D.
Professor K. W. Sykes, M.A., B.Sc., D.Phil.

ASSESSOR:

Ministry of Technology—D. Neville-Jones, M.A.

Secretaries: N. A. Keen, B.Sc., Ph.D., and P. S. Maxwell, B.Sc.

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The Rt. Hon. the Earl of Halsbury (*Chairman*).
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J. Howlett, Ph.D., A.M.I.E.E.
D. Michie, M.A., Ph.D.
R. M. Needham, M.A., Ph.D.
Professor I. N. Sneddon, M.A., D.Sc.
C. Strachey, M.A.
Professor N. S. Sutherland, M.A., D.Phil.
A. M. Uttley, B.Sc., Ph.D., A.F.R.Ae.S.

ASSESSOR:

Ministry of Technology—F. J. M. Laver, B.Sc.

Secretary: J. H. Price, B.Sc., Ph.D.

Electrical and Systems Engineering Committee

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S. S. Carlisle, M.Sc., M.I.E.E.
J. S. Forrest, M.A., D.Sc., F.Inst.P., M.I.E.E.

Professor R. T. A. Howell, B.Sc., Ph.D., M.I.E.E.
Professor Sir Willis Jackson, D.Sc., D.Phil., M.I.E.E., F.R.S.
Professor E. R. Laithwaite, M.Sc., Ph.D., D.Sc., M.I.E.E.
C. A. Laws, M.I.E.E.
W. Makinson, M.Sc., F.R.Ae.S., A.M.I.E.E.
Professor C. W. Oatley, O.B.E., M.A.
J. S. Stokes, B.Sc., A.M.I.E.E.
Professor J. C. West, Ph.D., D.Sc., M.I.E.E.

ASSESSOR:
Ministry of Technology—J. R. Mills, B.Sc., A.Inst.P.

Secretary: Miss V. E. M. Bowell, B.A.

Human Sciences Committee (Training Awards)

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Professor W. M. Gorman, B.A.
Professor K. Grebenik, M.Sc.(Econ.).
Professor H. Kay, M.A., Ph.D.
Professor D. J. Robertson, M.A.
Professor W. H. Scott, B.A., Ph.D.
Professor G. Westby, M.A.
Miss J. Woodward, M.A., D.P.S.A.

Secretary: F. E. Brown, M.A.

Mathematics Committee

Professor I. N. Sneddon, M.A., D.Sc. (*Chairman*).
Professor R. G. D. Allen, C.B.E., M.A., D.Sc.(Econ.), F.B.A.
Professor W. H. Cockcroft, M.A., D.Phil.
Professor J. N. Hunt, D.I.C., B.Sc., Ph.D., A.R.C.S.
J. G. Laski, M.A., Ph.D.
Professor D. V. Lindley, M.A.
Professor D. G. Northcott, M.A., Ph.D., F.R.S.
H. Robertson, B.Sc., Ph.D., F.I.M.E.
Professor C. A. Rogers, D.Sc., F.R.S.
Professor R. Thwaites, M.A., Ph.D.

Secretary: J. H. Price, B.Sc., Ph.D.

Mechanical and Production Engineering Committee

Professor H. Ford, D.Sc.(Eng.), Ph.D., M.I.Mech.E., M.Inst.C.E. (*Chairman*).
M. B. Coyle, M.A., A.M.I.Mech.E.
T. G. Fellows, B.Sc., D.I.C.
Professor W. B. Hall, B.Sc., M.I.Mech.E.
Professor S. P. Hutton, D.Eng., Ph.D., M.I.Mech.E., A.M.I.C.E., A.F.R.Ae.S.
Professor J. Loxham, C.G.I.A., M.I.Mech.E., M.I.Prod.E., F.B.I.M.
Ewen M'Ewen, M.Sc.(Eng.).
F. D. Penny, B.Sc., M.I.Mech.E.
Professor A. G. Smith, B.Sc., A.R.C.S., D.I.C., A.F.R.Ae.S., M.I.Mech.E.
R. Tilsley, M.I.Mech.E., M.I.Prod.E.
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Professor J. C. West, Ph.D., D.Sc., M.I.E.E.

Secretary : H. J. Ivey, B.Sc., Ph.D.

Mechanical and Production Engineering

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Professor J. Diamond, M.Sc., Wh.Sc., M.I.Mech.E.
T. Emmerson, A.Inst.P.
T. G. Fellows, D.I.C., A.M.I.Mech.E.
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Professor E. W. Parkes, M.A., Ph.D., A.M.I.C.E.
F. D. Penny, M.I.Mech.E.

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POSTGRADUATE TRAINING AWARDS COMMITTEE OF THE RESEARCH COUNCIL

Functions taken over, unless otherwise indicated, by the University Science and Technology Board on 1.9.65.

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Professor G. C. Drew, M.A.
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Brynmor Jones, Sc.D., Ph.D., F.R.I.C.
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D. M. A. Leggett, M.A., D.Sc., Ph.D., F.R.Ae.S.
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Professor A. D. Young, O.B.E., M.A., F.R.Ae.S.

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Department of Education and Science—C. Freedman.

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Professor R. A. Morton, Ph.D., D.Sc., F.R.I.C., F.R.S.
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Chemical Engineering and Metallurgy

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Professor C. W. Oatley, M.A.
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Professor A. G. Smith, M.I.Mech.E., A.F.R.Ae.S.
Professor A. S. T. Thomson, D.Sc., Ph.D.

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Functions taken over by the Natural Environment Research Council 1.6.65.

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Professor J. M. Bruckshaw, M.Sc., Ph.D., D.I.C.
Professor S. E. Hollingworth, M.A., D.Sc.
Professor D. L. Linton, D.Sc.
Professor L. R. Moore, D.Sc., Ph.D.
Professor W. S. Pitcher, Ph.D.
Professor F. H. T. Rhodes, Ph.D., D.Sc., F.G.S.

Human Sciences

Functions divided between the Social Science Research Council and the S.R.C. University Science and Technology Board 1.12.65.

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Professor E. Grebenik, M.Sc., (Econ.).
Professor H. Kay, M.A., Ph.D.
Professor W. H. Scott, B.A., Ph.D.
Professor G. Westby, M.A.
Miss J. Woodward, M.A., D.P.S.A.

Mathematics

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Professor R. A. Buckingham, Ph.D.
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Professor B. Thwaites, M.A., Ph.D.
Professor A. G. Walker, M.A., D.Sc., F.R.S.

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Professor B. Bleaney, M.A., D.Phil., F.R.S.
Professor R. J. Blin-Stoyle, M.A., D.Phil.
Professor R. G. Chambers, M.A., Ph.D.
Professor J. Dainty, M.A., D.Sc.
Professor G. F. J. Garlick, Ph.D., Sc.D., F. Inst.P.
Professor G. W. Hutchinson, M.A., Ph.D.
F. Y. Poynton, M.Sc., F.Inst.P.
Professor N. Kemmer, D.Phil, M.A., F.R.S.

HUMAN SCIENCES COMMITTEE

Functions taken over by Social Science Research Council. 1st December 1965.

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Sir William Carron, K.S.G., M.A., F.R.S.A.
Professor R. G. D. Allen, C.B.E., M.A., D.Sc., (Econ.) S.B.A.
H. A. Clegg, M.A.
A. G. P. Elliott, B.Com., F.I.P.M.
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Professor H. Kay, M.A., Ph.D.
W. M. Larke, C.B.E., C.Eng., M.A., M.I.Mech.E.
S. A. Robinson, A.B.S.I.
*J Wadsworth.
Rev. A. T. Welford, Sc.D.
D. E. Woodbine Parish, C.B.E., F.I.O.B.

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Ministry of Technology, J. Wardley Smith, B.Sc.
Ministry of Technology, S. W. Spain.

Joint Secretaries: A. B. Cherns, M.A. Miss H. M. T. Clay, M.A.

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* Resigned during the year.

APPENDIX III

SUMMARY OF THE EXPENDITURE OF THE COUNCIL DURING THE YEAR ENDED 31ST MARCH, 1966

Organisation	Gross	Receipts	Total
	£	£	£
London Office Administration	611,661	11,303	600,358
Rutherford Laboratory	5,998,859	177,230	5,821,629
Daresbury Laboratory	2,386,765	6,684	2,380,081
Atlas Laboratory	904,531	24,358	880,173
Radio and Space Research Station	1,257,191	9,396	1,247,795
Royal Greenwich and Cape of Good Hope Observatories	762,301	19,461	742,840
Royal Edinburgh Observatory	174,779	1,506	173,273
Grants to Universities and Other Bodies, etc.:			
Nuclear Physics	1,424,678	—	1,424,678
Upper Atmosphere	414,079	—	414,079
Other Researches	4,235,322	333,633	3,901,689
Postgraduate Training Awards	4,134,875	325,295	3,809,580
Space Research Central Expenses	953,053	—	953,053
Subscriptions to International Organisations:			
European Organisation for Nuclear Research	2,893,000	—	2,893,000
European Organisation for Space Research	1,750,000	—	1,750,000
N.A.T.O. Scientific Schemes	305,000	125,000	180,000
TOTALS	28,206,094	1,033,866*	27,172,228

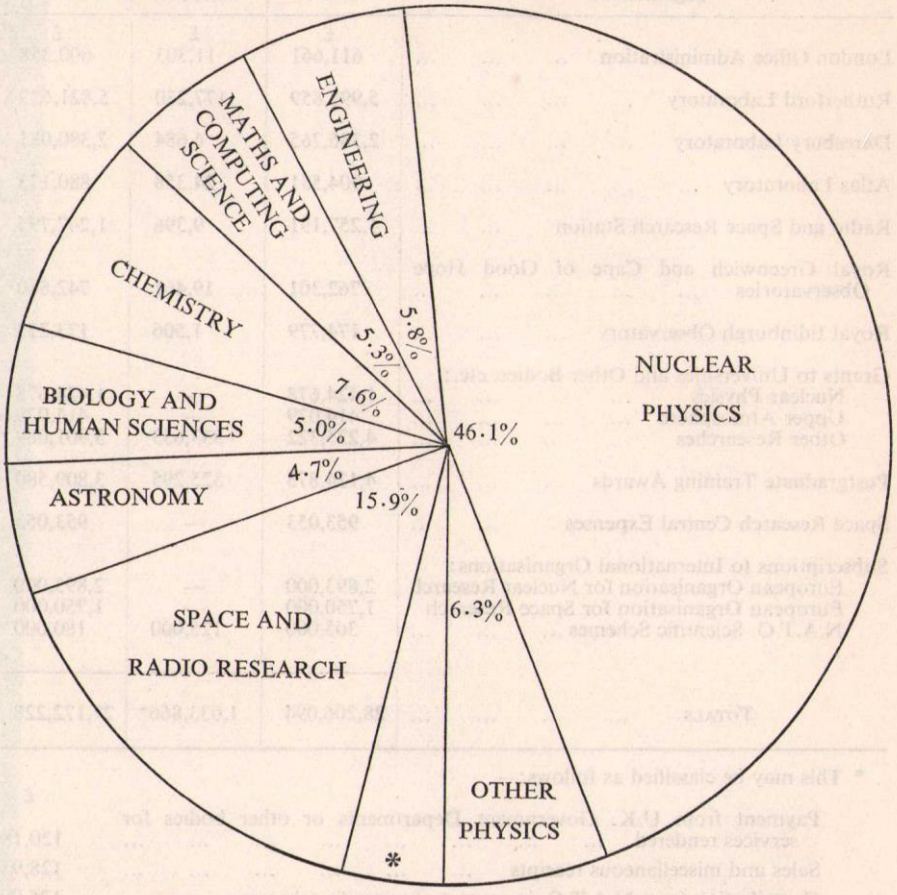
* This may be classified as follows:—

	£
Payment from U.K. Government Departments or other bodies for services rendered	120,180
Sales and miscellaneous receipts	128,934
Contribution from N.A.T.O. in respect of scientific schemes	125,000
Contribution from D.E.S. and N.E.R.C. for research grants in Earth Sciences	333,633
Contribution from D.E.S. and N.E.R.C. for training awards in Earth Sciences and Ecology	325,295
C.E.R.N. nominal audit fee	824
TOTAL	1,033,866

APPENDIX III

DIAGRAM 1

DIRECT EXPENDITURE BY DISCIPLINES—1965/6

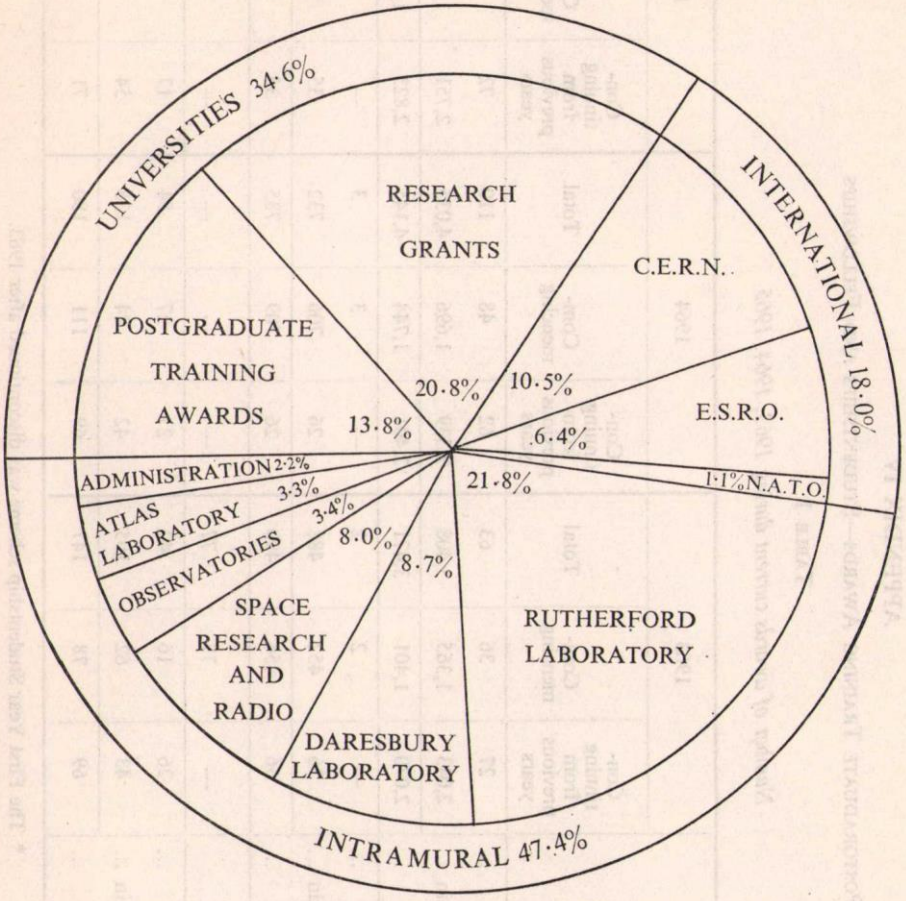


* This represents expenditure on Administration and on the U.K. Subscription to N.A.T.O. which cannot be allocated among disciplines (3·3%).

APPENDIX III

DIAGRAM 2

DIRECT EXPENDITURE BY SECTORS—1965/6



APPENDIX IV

POSTGRADUATE TRAINING AWARDS—STUDENTSHIPS AND FELLOWSHIPS

TABLE 1

Number of awards current during 1963, 1964, 1965

		1963			1964			1965		
		Continuing from previous years	Commencing	Total	Continuing from previous years	Commencing	Total	Continuing from previous years	Commencing	Total
Research Studentships	Held overseas	27	36	63	62	48	110	72	35	107
	Held in Great Britain ...	2,043	1,365	3,408	2,339	1,696	4,035	2,751	1,912	4,663
	Total	2,070	1,401	3,471	2,401	1,744	4,145	2,823	1,947	4,770
Advanced Course Studentships	Held overseas	—	2	2	—	3	3	—	—	—
	Held in Great Britain ...	36	452	488	26	706	732	35	911	946
	Total	36	454	490	26	709	735	35	911	946
First Year* Studentships		—	77	77	—	—	—	—	—	—
Research Fellowships	Held overseas	26	16	42	27	27	54	17	30	47
	Held in Great Britain ...	43	62	105	42	84	126	54	119	173
	Total	69	78	147	69	111	180	71	149	220

* The First Year Studentship scheme was discontinued after 1963.

TABLE 2

Distribution by subject of awards† current on 1st October, 1963, 1964, 1965

Subject	Research Studentships			Advanced Course Studentships			First Year Studentships*			Research Fellowships		
	1963	1964	1965	1963	1964	1965	1963	1964	1965	1963	1964	1965
Biology and Biochemistry	461	547	693	25	40	57	—	—	—	25	34	36
Chemical Engineering and Metallurgy	264	291	311	44	44	61	—	—	—	5	5	7
Chemistry	979	1,181	1,335	21	53	69	77	—	—	55	66	84
Electrical Engineering	161	202	239	36	41	58	—	—	—	2	3	1
Engineering (other)	291	357	429	85	149	177	—	—	—	3	4	4
Geology	240	274	282	26	42	56	—	—	—	10	18	21
Human Sciences	76	113	143	47	75	105	—	—	—	1	3	6
Mathematics	296	353	406	115	184	228	—	—	—	6	5	7
Physics	703	827	932	91	107	135	—	—	—	40	42	54
TOTAL	3,471	4,145	4,770	490	735	946	77	—	—	147	180	220

* The First Year Studentship scheme was discontinued after 1963.

† The Natural Environment Research Council and the Social Science Research Council became responsible in 1965 for some of these awards, mainly in Geology and the Human Sciences respectively.

APPENDIX V

Research Grants

(These grants are made for various periods, fixed beforehand, according to circumstances. Their cost during the year ended 31st March, 1966, is shown in Appendix III)

Table 1

Distribution, by Subject, of Applications Considered and Grants Awarded during Academic Years (October–September)

Applications Considered(1)				Subject	Grants Awarded(1)			
1962–63	1963–64	1964–65	1965–66 (Provisional)		1962–63	1963–64	1964–65	1965–66 (Provisional)
£'000					£'000			
596	1,036	1,153	1,436	Astronomy	270	340	313	515
791	1,023	1,295	1,894	Biology	446	541	712	1,016
1,232	1,908	2,105	2,249	Chemistry	725	1,124	1,096	1,256
—	491	769	530	Computing Science(2)	—	173	356	323
309(3)	33	48	78	Mathematics	42	14	40	23
686	1,356	1,410	1,186	Metallurgy and Materials	425	865	685	675
1,963	1,411	908	1,189	Nuclear Physics	1,353	978	677	472
(478)	(214)	(209)	(127)	Nuclear Research Reactors(4) ...	478	214	209	127
529	882	1,290	1,322	Other Physics	356	523	673	627
12	19	18	57	Radio	9	16	17	37
516	589	468	652	Space(5)	439	559	374	441
1,383	2,247	3,043	4,679	Technology	758	969	1,758	1,949
8,495	11,209	12,716	15,399	Total	5,301	6,316	6,910	7,461

(1) The difference between Applications Considered and Grants Awarded is accounted for by the value of applications that were reduced, rejected, withdrawn, transferred to other grant-giving bodies, or were deferred for further consideration; in the latter event the applications, often in revised form, are included in the figures for the following session.

(2) The Computing Science Committee was set up in 1963–64.

(3) Includes computing science projects to the value of £193,000 that were transferred in a revised form to the new Computing Science Committee.

(4) There are three Nuclear Research Reactors that receive major support from the Council. Support is provided, within previously agreed ceiling figures, to the end of the present quinquennium, i.e. 31st July, 1967.

(5) Prior to 1st April, 1965 the grants for Space Research were awarded by the former D.S.I.R. on the advice of the Royal Society's National Committee on Space Research as part of D.S.I.R.'s contribution to the government's space programme. Grants for Space Research are now considered and awarded by the Science Research Council.

TABLE 2

Distribution, by Subject, of Applications Considered and Grants Awarded during the Academic Year October, 1964–September, 1965

Subject	Applications deferred from previous session	New Applications	Grants Awarded	Applications rejected withdrawn or transferred	Applications deferred for further consideration
	£'000	£'000	£'000	£'000	£'000
Astronomy	637	516	313	802	38
Biology	116	1,179	712	457	126
Chemistry	94	2,011	1,096	776	233
Computing Science	24	745	356	281	132
Mathematics	—	48	40	8	—
Metallurgy and Materials	95	1,315	685	568	157
Nuclear Physics	—	908	677	218	13
Nuclear Research Reactors ...	—	209	209	—	—
Other Physics	79	1,211	673	478	139
Radio	—	18	17	1	—
Space...	—	468	374	94	—
Technology	479	2,564	1,758	826	459
TOTAL	1,524	11,192	6,910	4,509	1,297

TABLE 3

*Number of Senior Visiting Fellows included in S.R.C. Research Grants awarded during academic years, by geographical origin**

Origin	1963–64	1964–65
Europe	9	16
North America	18	30
Others	7	5
TOTAL	34	51

TABLE 4

*Number of Senior Visiting Fellows included in S.R.C. Research Grants awarded during academic years, by length of visit**

Length of visit	1963–64	1964–65
3 months or less	10	27
3–6 months	6	9
6–9 months	4	1
9–12 months	14	14
TOTAL	34	51

* Senior Visiting Fellowships are not necessarily taken up during the academic year in which a grant is awarded.

TABLE 5

Total Values of S.R.C. Research Grants, by Subject, at each University, Technical College or other Institution, current at 31st March, 1966

University	Astro-nomy	Biology	Chemistry	Com-puting Science	Mathe-matics	Metal-lurgy and Materials	Nuclear Physics	Nuclear Research Reactors	Other Physics	Radio	Space	Tech-nology	Total
	£	£	£	£	£	£	£	£	£	£	£	£	£
ENGLAND													
Aston	—	1,540	11,635	—	—	13,015	—	—	11,696	—	—	9,410	47,296
Birmingham	—	60,434	129,439	—	—	113,104	90,437	—	69,913	19,256	233,030	196,556	912,169
Bristol	—	19,632	61,691	—	—	32,750	19,000	—	—	—	—	68,696	201,769
Brunel	—	—	—	—	—	3,803	—	—	—	—	—	10,369	14,172
Cambridge	190,157	36,545	49,062	119,450	9,355	322,357	22,837	—	77,650	—	7,739	445,379	1,280,531
City	—	—	28,354	—	—	—	—	—	145	—	—	—	28,499
Durham	41,772	38,407	32,250	—	—	—	51,528	—	46,610	—	—	23,740	234,307
East Anglia	—	60,980	35,256	—	—	885	—	—	10,952	—	—	—	108,073
Essex	—	—	—	—	—	—	—	—	55,413	—	—	—	55,413
Exeter	—	6,714	12,542	—	—	—	—	—	14,520	—	—	9,075	42,851
Hull	44,316	33,085	5,859	—	—	—	—	—	—	—	6,454	1,555	91,269
Keele	—	—	40,117	10,564	—	—	—	—	7,178	—	—	—	57,859
Kent	—	—	18,350	—	—	—	—	—	—	—	—	—	18,350
Lancaster	—	—	9,896	—	—	19,050	—	—	15,234	—	—	—	44,180
Leeds...	179,517	48,877	183,804	—	—	31,359	—	—	18,882	—	35,023	130,251	627,713
Leicester	—	32,410	67,657	—	—	—	—	—	1,731	—	43,835	46,160	191,793
Liverpool	—	94,279	114,132	—	1,950	41,887	189,001	—	57,245	—	—	104,314	602,808
Loughborough	—	—	2,970	—	—	—	—	—	2,685	—	—	30,477	36,132
London:													
Bedford College	—	22,079	8,498	4,435	—	—	—	—	4,918	—	—	—	39,930
Birkbeck College ...	—	—	72,792	—	4,035	—	2,570	—	—	—	9,640	—	89,037
Goldsmiths College ...	—	—	368	—	—	—	—	—	—	—	—	—	368
Guy's Hospital Medical School	—	2,366	—	—	—	—	—	—	—	—	—	—	2,366
Imperial College	43,272	132,595	147,883	32,205	—	376,596	75,278	264,591	54,598	—	279,395	327,028	1,733,441
Institute of Computing Science	—	—	—	14,362	—	—	—	—	—	—	—	—	14,362
King's College	—	17,860	9,065	—	1,478	1,285	—	—	2,026	3,500	—	34,337	69,551
King's College Hospital...	—	—	3,867	—	—	—	—	—	—	—	—	—	3,867
Middlesex Hospital Medical School	—	2,990	—	—	—	—	—	—	4,000	—	—	—	6,990
Queen Elizabeth College	—	18,972	10,450	—	—	—	—	—	11,989	—	—	—	41,411
Queen Mary College ...	20,206	31,929	30,573	—	—	30,255	6,192	—	35,050	—	—	177,302	331,507
Royal Holloway College	—	9,896	22,166	—	—	—	—	—	41,454	—	12,384	—	85,900
Royal Free Hospita) ...	—	10,829	—	—	—	—	—	—	—	—	—	—	10,829
School of Laryngology ...	—	—	—	—	—	—	—	—	—	—	—	17,504	17,504
School of Pharmacy ...	—	—	—	—	—	—	—	—	—	—	—	1,661	1,661
St. Bartholomew's Hospital	—	2,651	—	—	—	—	—	—	—	—	—	—	2,651
University College ...	22,465	126,987	74,914	40,155	3,350	—	84,093	—	16,320	—	440,000	42,036	850,320
Westfield College ...	—	17,731	22,987	—	—	—	42,431	—	18,115	—	—	—	101,264

TABLE 5—*contd.*

University	Astronomy	Biology	Chemistry	Computing Science	Mathematics	Metallurgy and Materials	Nuclear Physics	Nuclear Research Reactors	Other Physics	Radio	Space	Technology	Total
	£	£	£	£	£	£	£	£	£	£	£	£	£
Manchester University ...	302,704	8,380	64,514	3,748	—	36,573	125,450	128,537	54,420	—	24,737	45,054	794,117
University of Manchester Institute	—	—	31,043	—	—	104,433	—	—	10,209	—	—	218,491	364,176
Newcastle	—	103,984	119,985	—	8,670	131,600	—	—	38,460	—	—	212,840	615,539
Nottingham	—	18,472	30,723	4,435	1,550	8,900	16,210	—	48,550	—	—	86,234	215,074
Oxford	77,330	96,880	182,688	41,000	—	53,338	1,228,668	—	258,204	—	36,848	124,056	2,099,012
Reading	—	6,497	37,006	—	—	30,592	—	—	62,452	—	32,637	9,350	178,534
Sheffield	—	87,051	58,938	—	—	187,898	—	—	106,652	31,611	58,888	98,201	629,239
Southampton	—	44,315	75,401	—	—	—	2,000	—	31,745	—	97,762	334,320	585,543
Sussex	81,100	8,087	42,599	—	—	12,815	24,770	—	79,996	—	—	5,433	254,800
Warwick	—	—	12,126	—	9,890	10,380	—	—	15,770	—	—	4,020	52,186
York	—	800	6,638	—	—	15,898	—	—	13,697	—	—	—	37,033
SCOTLAND													
Aberdeen	—	36,542	53,377	3,248	—	—	—	—	8,987	—	—	3,565	105,719
Edinburgh	—	117,553	61,461	169,620	—	11,191	6,907	—	12,215	—	—	38,688	417,635
Glasgow	—	20,885	83,591	3,665	1,365	42,996	1,145,527	—	—	—	2,365	242,399	1,542,793
St. Andrews	3,250	17,580	96,148	—	—	3,151	—	—	44,982	—	—	6,317	171,428
Scottish Research Reactor Centre	—	—	4,458	—	—	—	—	157,443	—	—	—	—	161,901
Strathclyde	—	5,341	14,971	—	13,286	37,793	—	—	34,367	—	—	65,060	170,818
ULSTER													
Belfast	—	31,380	17,823	—	—	26,435	—	—	4,460	—	48,040	40,448	168,586
WALES													
Aberystwyth...	—	58,144	7,547	—	—	—	—	—	23,437	36,216	47,783	6,145	179,272
Bangor	—	25,101	11,512	—	—	55,071	—	—	32,571	—	—	74,077	198,332
Cardiff	—	1,370	19,804	—	4,375	14,075	—	—	2,530	—	—	70,369	112,523
Swansea	—	9,104	42,007	—	—	25,283	—	—	—	—	—	54,519	130,913
TOTAL FOR UNIVERSITIES ...	1,006,089	1,527,254	2,280,937	446,887	59,304	1,794,768	3,132,899	550,571	1,462,028	90,583	1,416,560	3,415,436	17,183,316
OTHER INSTITUTIONS													
Battersea College of Technology	—	—	18,902	—	—	66,930	3,760	—	2,940	—	—	42,720	135,252
Belfast College of Technology	—	—	6,315	—	—	—	—	—	—	—	—	—	6,315
Blackburn College of Technology	—	—	—	—	—	—	—	—	3,000	—	—	—	3,000
Borough Polytechnic ...	—	—	—	—	—	—	—	—	7,750	—	—	6,497	14,247
Bradford Institute of Technology	—	650	13,902	—	3,096	—	9,000	—	—	—	—	57,084	83,732
Brighton College of Technology	—	—	3,145	—	—	2,138	—	—	810	—	—	1,082	7,175
Bristol College of Science and Technology	—	3,674	2,918	—	—	3,290	—	—	—	—	—	21,515	31,397

TABLE 5—*contd.*

University	Astro-nomy	Biology	Chemistry	Com-puting Science	Mathe-matics	Metal-lurgy and Materials	Nuclear Physics	Nuclear Research Reactors	Other Physics	Radio	Space	Tech-nology	Total
	£	£	£	£	£	£	£	£	£	£	£	£	£
Chelsea College of Science and Technology	—	—	9,926	—	—	—	—	—	—	—	—	—	9,926
Constantine College of Technology	—	—	—	—	—	5,350	—	—	—	—	—	—	5,350
Derby and District College of Technology	—	—	—	—	—	—	—	—	—	—	—	4,272	4,272
Dundee Institute of Art and Technology	—	—	—	—	—	8,790	—	—	—	—	—	—	8,790
Grimsby College	—	—	732	—	—	—	—	—	—	—	—	—	732
Heriot-Watt College ...	—	1,154	3,212	—	—	—	—	—	—	—	—	39,480	43,846
Huddersfield College of Technology	—	—	700	—	—	—	—	—	—	—	—	—	700
John Dalton College of Technology	—	—	675	—	—	11,755	—	—	—	—	—	—	12,430
Kingston College of Technology	—	—	2,550	—	—	—	—	—	—	—	—	—	2,550
Lanchester College of Technology	—	—	—	—	—	9,942	—	—	—	—	685	—	10,627
Liverpool College of Technology	—	1,604	1,030	—	—	—	—	—	3,300	—	—	2,590	8,524
Monmouthshire Technical College	—	—	—	—	—	250	—	—	—	—	—	—	250
North Staffordshire College of Technology	—	—	880	—	—	—	—	—	—	—	—	—	880
Plymouth College of Technology	—	—	—	—	—	—	—	—	—	—	—	2,441	2,441
Portsmouth College of Technology	—	—	—	—	—	—	—	—	1,904	—	—	—	1,904
Regent Street Polytechnic, London	—	—	—	—	—	—	—	—	—	—	—	150	150
Royal College of Advanced Technology, Salford ...	—	—	1,700	—	—	—	—	—	—	—	—	20,777	22,477
Rutherford College of Technology	—	—	3,710	—	—	2,265	—	—	4,069	—	—	2,000	12,044
Sir John Cass College ...	—	—	11,268	—	—	37,337	—	—	—	—	—	—	48,605
S.E. Essex College of Technology	—	—	—	—	—	—	—	—	—	—	—	3,835	3,835
Sunderland Technical College	—	—	—	—	—	11,790	—	—	—	—	—	—	11,790
Tavistock Institute of Human Relations	—	—	—	—	—	—	—	—	—	—	—	17,911	17,911
Welsh College of Advanced Technology, Cardiff ...	—	—	2,749	—	—	—	—	—	13,362	—	—	2,100	18,211
West Ham College of Technology	—	—	—	—	—	—	—	—	14,440	—	—	—	14,440
Wigan and District Mining and Technical College ...	—	—	—	—	—	3,290	—	—	—	—	—	—	3,290

TABLE 5—*contd.*

University	Astro-nomy	Biology	Chemistry	Com-puting Science	Mathe-matics	Metal-lurgy and Materials	Nuclear Physics	Nuclear Research Reactors	Other Physics	Radio	Space	Tech-nology	Total
	£	£	£	£	£	£	£	£	£	£	£	£	£
Wolverhampton and Staffordshire College of Applied Science	—	—	1,747	—	—	—	—	—	—	—	—	—	1,747
College of Aeronautics, Cranfield	—	—	—	—	—	14,706	—	—	—	—	—	131,635	146,341
Engineering Employers West of England Association ...	—	—	—	—	—	—	—	—	—	—	—	8,135	8,135
Private Communications Laboratory, Hale ...	—	—	—	—	—	—	—	—	—	—	—	350	350
Private Observatory, Ascot	1,400	—	—	—	—	—	—	—	—	—	—	—	1,400
Royal College of Surgeons	—	—	—	—	—	—	—	—	5,183	—	—	—	5,183
Royal Greenwich Observatory	19,060	—	—	—	—	—	—	—	—	—	—	—	19,060
Royal Military College of Science, Shrivenham ...	—	—	2,650	—	—	6,229	—	—	5,700	—	—	—	14,579
Royal Naval College ...	—	—	—	—	—	4,395	—	—	—	—	—	—	† 4,395
Royal Society	—	—	—	—	—	—	—	—	—	—	1,400	—	1,400
TOTAL FOR OTHER INSTITUTIONS	20,460	7,082	88,711	—	3,096	188,457	12,760	—	62,458	—	2,085	364,574	749,683
GRAND TOTAL ...	1,026,549	1,534,336	2,369,648	446,887	62,400	1,983,225	3,145,659	550,571	1,524,486	90,583	1,418,645	3,780,010	17,932,999

APPENDIX VI

ESTABLISHMENTS OF THE SCIENCE RESEARCH COUNCIL

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