orbit

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Recent Developments in Elementary Particle Physics

by P G Murphy

Summary

An account of recent developments of some aspects of elementary particle research, concentrating on a few topics which are currently being studied intensively in several Laboratories. Recent experiments have cast doubt on one theory (Regge poles) confirmed another (Unitary Symmetry) and cast doubt on an 'invariance' rule (CP-invariance). Other experiments are continuing with a view to checking theories further, while certain fields are being studied in the hope that accummulated data will reveal theories that have not yet been discovered. Nimrod will be making substantial contributions to all these fields of physics, with obvious limitations in the case of high energy experiments. These experiments have now reached the limit where a new very large machine is required.

Cover photographs: The arrival in its crate at the Nimrod Experimental Hall of the 80 centimetre hydrogen bubble chamber from Saclay, in June 1964. The chamber is now in operation on the K1 beam line and the second photograph, taken at the end of 1964, shows one of the first bubble chamber pictures from Nimrod.

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High Energy Scattering

At the time of the 1962 International Conference at CERN there was great optimism that the "Regge pole" theoretical model might give a simple description of the scattering of any one type of particle by any other. In this model the force between two particles is mediated by the exchange of an object known as a "Regge pole"; this expression describes the purely mathematical behaviour of the exchanged object in the theory. Experimentally it can be produced as a physically observed particle; different Regge poles correspond to different particles such as the proton or the π meson. The first hope was that a fairly simple theory based on a small number of Regge poles would describe all scattering experiments at sufficiently high energy; it was also hoped that the particles produced by the high energy accelerators at Brookhaven and CERN would be in this energy range (the theory could not predict its own range of applicability). Early experiments on the scattering of protons by protons gave results which followed the predictions very closely; this was the reason for great optimism. The scattering angular distribution was observed to be peaked in the forward direction; the peaking became sharper as the energy increased, as had been predicted. The same behaviour was expected for the scattering of other particles by protons. However, accurate experiments carried out at Brookhaven showed that this effect certainly does not occur for π mesons or negative K mesons.

A general theorem due to Pomeranchuk states that, with some simple and very fundamental assumptions, the total cross-section presented by one particle to another striking it, should tend to a constant value as the energy of the projectile particle increases. When this constant value is reached, the cross-sections for any particle and its anti-particle striking the same target should be equal. Very accurate measurements have been made for πmesons, K mesons, neutrons and anti-protons striking protons or neutrons. Up to the highest energies attainable by present day accelerators (about 25 GeV) only the K^+-proton total cross-section is anything like constant as a function of energy, and no pairs of anti-particles have reached equality. Another simple feature expected at very high energies is that the scattering process, which is in general described by a complex value of the scattering "amplitude", should have a purely imaginary forward scattering amplitude. Recent experiments at CERN, Dubna and the Rutherford Laboratory have shown that there is an appreciable real part in this amplitude for the scattering of protons by protons. The P2 experiment at Nimrod carried out by a team with members from AERE, Queen Mary College and the Rutherford Laboratory has given some of the most accurate measurements of this real part of the amplitude.

It is clear that the "asymptotic" energy region where the Regge pole theory (if it is true), Pomeranchuk's theorem and the vanishing of the real part of the forward scattering amplitude become good approximations, has not been attained by present-day accelerators.

Higher symmetry

All physical theories depend on basic assumptions of invariance properties. Most of these are connected with symmetries with respect to space and time. For example, all physical laws are assumed to be unchanged if the whole system under study is rotated through any angle, or if the system is described by an observer moving past it instead of being at rest. Recently a new invariance property has been discovered called Unitary Symmetry. This is a "higher" symmetry in that it does not refer to motions in ordinary space-time but in a special space of its own. The symmetry is an invariance of the laws of physics when different particles are mixed together in a mathematical operation known as a unitary transformation. A consequence of the theory is that elementary particles should occur in groups of definite numbers, the smallest being groups of 8, 10 or 27. The resonances, which are very short-lived combinations of two or more particles (or sometimes a combination of particles and other resonances) also fall into the same pattern. In fact, there is no reason to distinguish between resonances and elementary particles; the resonances are short-lived only because they are very heavy. In the unitary symmetry theory all the particles in one group can be mixed together. For this to be permissible all the members of one group should have the same mass, the same spin angular momentum and the same parity (difference of behaviour when observed in a mirror; it can be positive or negative). One group of eight contains the neutron, proton, lambda hyperon, positive, negative and neutral sigma hyperons and two cascade hyperons. If the theory were exactly true

then the world could equally well be described in terms of two new particles, each of which could be thought of as a mixture of the proton and the positive sigma hyperon; the proton would no longer exist as a distinct particle. This is not so because the theory is approximate; while these eight particles do have the same spins and parities, their masses are slightly different from one another. However, it is a good enough approximation for the grouping into 8, 10, 27 etc. to remain quite distinct. Shortly after the theory was put forward by Gell-Mann and Ne'eman in 1961 it was realised that there existed nine resonances each with spin $1\frac{1}{2}$ atomic units of angular momentum and positive parity; a tenth was needed to complete a "unitary multiplet". Gell-Mann and Okubo had discovered how to calculate the mass differences of the particles in a multiplet; Okubo's formula showed that the mass of the tenth member of the multiplet should be such that it would be a relatively long-lived particle rather than a resonance. The discovery of this new particle, the Ω^-, early in 1964 at Brookhaven after vigorous searches in all the world's high energy laboratories, was a dramatic success for the theory. On the other hand, if it had not been found the theory would probably have been rejected. Other successes of the theory have been the confirmation of the mass formulae and a measurement of the magnetic moment of the lambda hyperon which is consistent with the prediction of Unitary Symmetry. There are still almost a hundred resonances which have not been classified into unitary multiplets. For most of them their spins and parities have not yet been measured; until this is done it is obvious that the classification cannot be made. Much work is proceeding in this field. At Nimrod three groups (two Rutherford Laboratory, Oxford University groups and a University College, Westfield College, group) are measuring the properties of several π meson-proton resonances. A group with members from the Rutherford Laboratory and several Universities is collaborating with a French group who have brought an 80 centimetre hydrogen bubble chamber to Nimrod from Saclay. They will study a variety of resonances.

A more subtle test of Unitary Symmetry is being made at Nimrod (K2 experiment) by a joint Imperial College, Manchester University team, who are studying the rare decay of the ω^0 resonance into a pair of electrons.

Many aspects of Unitary Symmetry could be understood if there existed three basic particles from which all others would be constructed by various combinations. These particles called "quarks" by Gell-Mann and "aces" by Zweig, would have peculiar properties; for example they would have electric charges of 1/3 or 2/3 that of the electron. These particles should be easily recognisable when they occur, so searches for them have been carried out at CERN and Brookhaven quite quickly. They have not been found; the conclusion is that if they exist then they must be too heavy to be made by 30 GeV protons; a much higher energy machine is needed to create them.

Weak Interactions

The weak interactions cause the beta-decay of radioactive isotopes, the decay of unstable particles and the interactions of neutrino beams with matter. There are always four particles involved in a weak interaction. For example, the neutron decays into a proton, an electron and a neutrino. The four particles can always be arranged in two

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(A poem written at CERN at the time of the search for quarks)

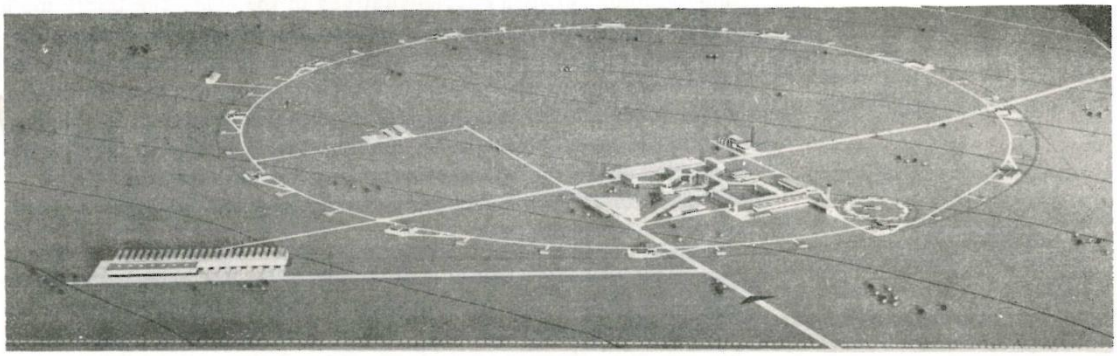
Think of the words that our subject is fraught with,
Words that old Webster would never be caught with,
Ladders and tadpoles and majorization,
Bootstraps and buddahs and peratization,
Hafnians, pfaffians, some think it's drollish,
Why, half of the world speaks Regge Polish!
Things are so bad that I must protest it,
From Joycean footnotes, please give us some respite!
Oh, horrible thought if in nature 'tis observed,
That the quarks and the aces,
Keep changing their places,
And charge seems never conserved!

pairs - in the case of neutron decay the neutron and the proton form one pair and the electron and neutrino form the other pair. It has been observed that the arrangement of particles in pairs in the weak interactions obeys certain rules. One rule is that in each pair, one particle must be charged and the other neutral. Another rule governs the way in which the hyperons can be involved. This latter rule was found to be obeyed very accurately in experiments carried out earlier this year at Berkeley, CERN and Brookhaven; physicists from the Rutherford Laboratory took part in the CERN experiment. "Selection rules" of this sort do not occur without reason. For example, selection rules governing the spectra emitted by hot gases were discovered in the nineteenth century. The theory of quantum mechanics developed in the nineteen twenties showed how these selection rules were consequences of invariance with respect to rotations and reflections in space. In the case of weak interactions there would be an explanation of the selection rules if there existed a family of particles called the "vector-bosons". In neutron decay the neutron could become a proton and simultaneously emit a "virtual" vector boson; the vector boson would then decay into an electron and a neutrino. (The word "virtual" means that the boson itself cannot be observed in the decay; it is so heavy that energy conservation would be violated. It plays a purely intermediary rule). All the weak interactions would take place by the exchange of vector bosons between the pairs of particles. If all vector bosons were electrically charged it follows that each pair of particles must have a net charge. Other universal rules of the weak interactions would have similar straightforward explanations. If they exist, the vector bosons should be produced when high energy neutrinos are used to bombard neutrons and protons; an experiment of this sort completed recently at CERN produced no vector bosons. The conclusion is that if they exist the vector bosons must be very heavy - too heavy to be produced at the CERN accelerator; a higher energy accelerator is needed to continue the search.

It was discovered in 1956 that the phenomena of the weak interactions do not remain invariant when the laboratory is replaced by a mirror-image system; "parity conservation is violated in weak interactions". It was immediately postulated that nevertheless a mirror-image laboratory would behave the same so long as all particles were replaced by anti-particles (an operation known as "charge-conjugation"). In other words the universe was believed to be "CP-invariant" (C for charge conjugation, P for parity). Experiments to test this rule are difficult; no very accurate ones had been done until this year. Recently an experiment at Brookhaven has shown that CP-invariance is violated to the extent of two parts in a thousand in the decay of long-lived neutral K-mesons. There are two kinds of neutral K-meson; if CP-invariance were exact then the short-lived K^0_1 can decay into a pair of π mesons while the long-lived K^0_2 cannot. The Brookhaven experiment found a small number of events of K^0_2 mesons decaying into two π mesons. This unexpected result has stimulated great interest throughout the world; at the Rutherford Laboratory an experiment on K^0_2 decay is being carried out by a joint Rutherford Laboratory, AERE, Bristol University team.

The role of Nimrod

Before the start-up of Nimrod, experimental work in high energy physics was carried out



A CERN model of the proposed 300 GeV machine which may answer questions raised by the recent developments covered in this article. The main ring would be $1\frac{1}{2}$ miles in diameter. The booster synchrotron ring and the large experimental hall can be seen on the model.

mainly at three centres - Berkeley, CERN and Brookhaven. While most data has come from these laboratories, there have also been significant contributions from Dubna in in the USSR and several electron accelerators in the USA, France and Italy. In addition, a number of synchrocyclotron laboratories have made detailed studies of the properties of neutrons, protons and π and μ mesons. Nimrod has a maximum energy of 8 GeV; at present the intensity under normal conditions (measured in protons per second) is nearly as high as the normal running intensity of the 6 GeV Bevatron (which has the highest beam intensity in the world). The extra energy allows mesons of appreciably high momentum to be produced; it also gives an increase in the intensities of 1 to 2 GeV/c mesons. In comparison with the Bevatron, Nimrod has many advantages; it has been designed in such a way that many experiments can be set up at the same time; when required, the mesons can be produced as a steady stream lasting for half a second, rather than as a short burst which is often difficult to handle. Thus Nimrod has stepped immediately into the front line of elementary particle research. It will be possible to do many experiments on resonances, particle decays and some features of particle scattering - fields in which there is many years' work to be done. British physicists are extremely fortunate in having one of the five major proton accelerators in the world for their own use.

THE Accelerator WORLD

News and views from the world of high energy physics, accelerators, and computers.

Final Report of the ACSP

The 1963-64 Annual Report of the Advisory Council on Scientific Policy was published in December, 1964. The Council has now been disbanded in the reorganisation of the country's science, following the recommendations of the Trend Report. The following extracts are taken from Section II of the Report, "High Energy Physics and the National Programme of Science Research."

'The possibility of inter-continental co-operation (in the next generation of accelerators) was examined at meetings in Vienna this summer between representatives of the USA, the USSR and of European countries. There seemed unfortunately no immediate prospect of inter-continental collaboration in the construction of an accelerator of energy in the 300 GeV range and the time was shown to be not yet ripe for discussing inter-continental collaboration in the construction of an accelerator of energy in very much higher ranges. These meetings, therefore did nothing to ease the decisions which European Governments will be asked to take on the CERN proposals.

. . . The proposals of the nuclear physicist are based on a strong scientific case. But the claims for support for other subjects are equally strong scientifically; it would be more than rash to say, for example, that man would gain more from understanding the nucleus of the atom than the nucleus of the living cell. It is not relevant to the issue that it costs much more to do effective work in high energy physics than in, say biology.

. . . We conclude that the sum required annually for the field of scientific research defined as above (excluding DSIR and AEA) would be £145 million in 1969-70, compared with £77 million in 1964-65. This includes the cost to the United Kingdom of the European programme which - provided both of the new projects are approved and that the United Kingdom financial contribution is 25 per cent. of the total as in the existing CERN organisation - would be £10.7 million in 1969-70 in place of £2.4 million in 1964-65. The cost of our national effort at the National Institute for Research in Nuclear Science, if all the proposed developments were implemented, would amount to £14 million in 1969-70 in place of £9½ million five years earlier.

. . . To conclude, the Council accept the CERN proposals as scientifically desirable and have recommended that these proposals for developing high energy physics in the United Kingdom should be supported by Government, provided that the requirements of other fields of science on the scale indicated are also satisfied. If however, the scale of support for scientific research should be in excess of what Government are prepared to accept, then it will be necessary to give further consideration to the relative priorities of high energy physics and of other areas of scientific research before any final decision on the CERN proposals can be reached.'

News from CERN

The 28th Session of the CERN Council was held in Geneva on 15, 16 December, 1964.

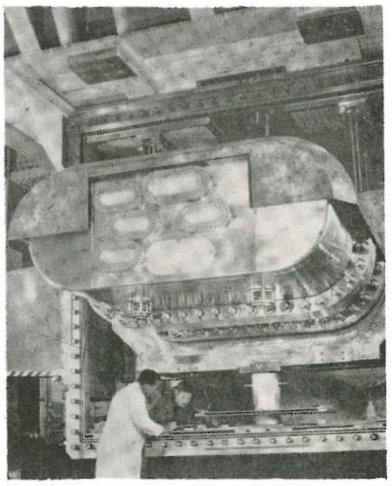
Professor Weisskopf reported on the continued successful operation of the 28 GeV proton synchrotron and the 600 MeV synchro-cyclotron; the operation of the worlds' first microwave separator and of the 2 metre bubble chamber (see below). In high energy physics over the past six months CERN contributed to the discovery of new resonances and the determination of their characteristics; established that at high energies the collision of two protons shows a surprisingly large degree of true elasticity; demonstrated that the weak interaction boson, if it exists, must have a mass at least 1.8 times that of the proton, and contributed to the experimental work on SU_3 theory.

The budget for 1965 was approved as 128,760,000 Swiss francs (1 SF is equivalent to about 1s 8d) an increase of about 20 million SF. A figure of 135 million SF was approved for 1966. Britain contributes about a quarter of the funds.

Professor Leprince-Ringuet, chairman of the Scientific Policy Committee recommended a three part programme of future development. According to the Committee, none of the three parts should be considered as having priority; the various proposals forming a coherent whole -

1 To improve the existing facilities at CERN - increasing the intensity of the synchrotron; extending experimental areas and providing new experimental equipment. 12% per annum on the CERN budget is suggested to cover this proposal.
2 To build storage rings at the synchrotron. A decision is needed quickly to provide this very high energy facility by 1971. The latest estimate is £26 million and the Council will meet again in March to decide on this project.
3 To build a 300 GeV proton synchrotron. This project is estimated at £120 million and a decision is desirable by 1966 or 1967. The Council decided that studies will continue and countries have been asked to recommend possible sites.

It was announced from CERN on 15 December, 1964 that photographs of particle tracks had been taken for the first time with the 2 metre hydrogen bubble chamber. This chamber takes over from the $1\frac{1}{2}$ metre British National Hydrogen Bubble Chamber as the largest in Europe. (A hydrogen chamber at the Brookhaven Laboratory, USA is 203 centimetres long.) Design of the 2 metre chamber began in 1959. It contains 1050 litres (275 gallons) of liquid hydrogen at $-245^{o}C$ surrounded by a magnet weighing 400 tons. Four cameras, using 50 mm film, photograph the tracks of bubbles in the wake of charged particles through a glass window 2 metres long, 60 centimetres high and 17 centimetres thick.



The camera side of the 2 metre chamber during pressure tests at CERN six months ago.

Trouble with London Atlas

A story of discontent with the ICT Atlas Computer at London University appeared in The Observer on 13 December, 1964. The Science Correspondent, John Davy reported:

"It was expected that the university would have full use of the computer by last March. But it is still being worked on by the manufacturers, International Computers and Tabulators, whose managing director is Mr. Basil de Ferranti, and there are many technical problems still to be overcome.

. . . The troubles are more than technical. They show once again that the British problem is not a shortage of ideas but failure to realise them effectively in practice. The affair came to a head early last week with a heated memorandum which the staff sent to their director, Professor R.A.Buckingham. The memorandum says, 'in our professional opinion, Atlas is at present totally unacceptable to the University'.

. . . Mr. de Ferranti conceded that the machine's hoped-for performance had not yet been achieved. But he insisted: "It is an extraordinarily fine machine, which represents a technological breakthrough, and can do more work than any other computer now working". The toughest problem was the "software" - particularly the supervisory program, the complex instructions which enable the machine to handle many tasks simultaneously. At present the machine was working "four to five hours a day, during which it gets through several hundred jobs". But eventually it should get through several thousand jobs. "We shall get there", he insisted.

Several research projects have had to be scrapped or diverted elsewhere. An Imperial College scheme to analyse nuclear physics results at high speed through a direct link with Atlas had been abandoned. The team is now using an American machine in Darmstadt, Germany, which they are allowed to use cheaply at weekends.

ICT experts now concede that when Atlas was started four years ago the magnitude of the task was not fully appreciated. It was a task,

most now agree, which should have had Government support. This lesson may now have been learned - there is much talk in Mr. Cousins' new Ministry of Technology about supporting "software development."

At the Whitley Council meeting on 14 December, 1964 the Staff side drew attention to the adverse publicity. Dr. Pickavance said that the NIRNS Atlas had been made after the London one. So far its behaviour was promising.

Progress at Daresbury

Professor Merrison, Director of the Daresbury Nuclear Physics Laboratory made the following statement at the Whitley Council Meeting on 14 December, 1964:

". . . good progress has been maintained, both with the buildings and NINA Plant. The first major components of NINA have started to arrive and preliminary tests with them have been very encouraging. We are still keeping well to our programme which calls for acceleration in October, 1966.

The staff at the Laboratory has now increased to 138, and we expect to go up to 160 by March, 1965, which is above our previously agreed complement of 140. The increase which we have found necessary here is almost entirely in support staff.

Daresbury has managed to reach the front pages of national newspapers for the first time. This occurred when we were boring under the canal to lay a sewage pipe. Unfortunately the canal was pierced and this caused minor flooding in the area. The incident was brought under control very quickly and the damage done to neighbouring land and property was very slight."

QUOTES

"We have noticed that many breakdowns are due to insufficient lubrication - or even to a complete lake of it".

Extract from the Handbook of a new machine in the R.9 Workshop.

"Report writing, like motor-car driving and love-making, is one of those activities which almost every Englishman thinks he can do well without instruction. The results are of course usually abominable"

Tom Margerison, reviewing "Writing Technical Reports" by Bruce M. Cooper, in the Sunday Times, 3 January.

Cathy Gale "What do you get out of this ?"

Girl "Money."

Cathy Gale "Scientific assistants don't get much money."

"The Avengers" I.T.V., Thursday, 14 Jan.

"Once again (F. Bulos et al. Phys. Rev. Letters 13, 486, 1964) the high energy physicists have presented us with a paper that has more authors (27) than paragraphs (12) . . . Can high energy really be so different ?"

Robert A. Myers Letter to "Physics Today", Nov. 1964.

The Great Neutrino War (in 96 parts)

Part 1

Few people who lived through that glorious summer of 1984 are likely to forget it. As the halcyon days went on through June and July and into August, none of us at the Lab. thought that we were on the brink of the greatest scientific conflict that mankind had ever seen. On the morning of 14 August, my diary records that I went along to the Lab. as usual. There were little groups of physicists in the corridors and clustered round the notice boards, all talking animatedly. I went up to one group in which I'd noticed Reggie Littlehampton.

"This looks like it, Roy," he said excitedly, "at least now we know where we stand."

He pointed to a copy of the Brookhaven Ultimatum pinned to the notice board and I managed to read the first few lines.

"The United States Government has observed the entry of Great Britain into the field of neutrino physics. This aggressive act against our scientific sovereignty is a flagrent violation of international agreements. Unless Great Britain withdraws from this field by midnight of 14 August, the United States Government will be forced to launch an all-out attack . . .

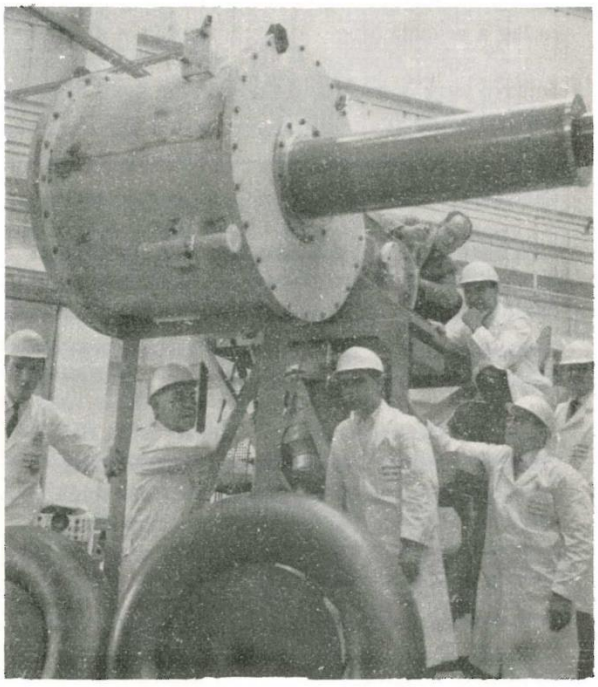
None of us thought that the Old Country would back down - we'd all seen the effects of appeasement in the past.

It was war.

Reggie and I decided to stroll over to the coffee lounge to see if there was any later news. When we got there we saw that workmen with oxy-acetelene equipment were cutting off the table legs to melt down for magnet sectors. Somehow I knew then that we would win through in the end. We sat cross-legged on the floor drinking our coffee and waited for a telecast by the Prime Minister. I remember clearly how his drawn face and grave voice struck a chill in my heart.

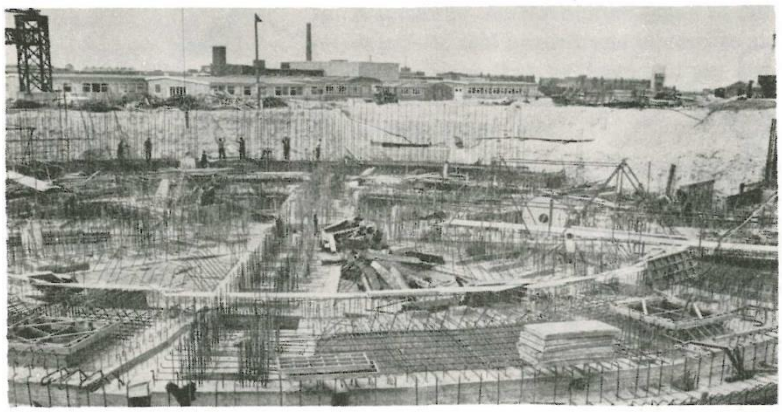
"The news from Brookhaven is bad . . ."

His words confirmed my worst fears - as I had suspected, the Americans had been secretly building up their armoury of accelerators so that now, because of our own apathy, they were able to put in the field a force far superior to ours in both men and material. It became clear that their much publicised Institutes for the application of research to industry were mere covers for the training of machine builders. Ever since the misguided 'anti-prestige' move-



Officers and men of the 19th Nimrod Division manhandling one of their ion guns into position in the front line, early in the war. This rare photograph shows, at the back, Scientific Assistant Charlie Bloogs, now Sir Charles Bloggs F.R.S., D.Sc., M.Inst.P., Director General of CERN. He distinguished himself, during the battle of Neutrino itself, by building a 100 ton shield wall single handed, without which the experiment would have had to be stopped. He was later described as 'the only man who could have lost the war in an afternoon'.

Some of the devastation caused to the beautiful English countryside as the War proceeded.



ment in the middle sixties, our machine technology had stagnated and now we were faced with the appalling task of building a 1000 GeV synchrotron in two years entirely out of our own resources - for I knew that the Government had firmly resolved to go it alone. We all knew the tremendous sacrifices that would be required of the whole community, though few knew, as I did, of the true weakness of our position.

When the P.M. had finished, Reggie turned to me with a serious expression.

"Well Roy, you were right. When the United Nations parcelled up large scale science among different countries to avoid duplication of effort, it seemed to me a good idea. I was wrong - will you shake on it ?"

As we shook hands, I was moved by this handsome gesture on Reggie's part - we had been opponents on the subject for many years. The notion of 'Scientific Sovereignty' as it came to be known is all very well in theory, but hopelessly idealistic in practice. Nobody can predict which fields of research will yield the important, impressive results, and scientific territory by 1984, had become just as coveted as 'lebenstaum' was earlier in the century. What powerful nation could stand by and watch a smaller one stumble on some important new discovery without exploiting the new field itself ?

We made our way back to my office where I intended to wait for the telephone call which I knew would summon me to Whitehall to take up my wartime duties. As we walked into the hot sunshine Reggie suddenly burst out.

"I say Roy, can't I do anything to help ? I mean, should I fill some sandbags for a shield wall ? And what about electrical power ? It was bad enough in the old days with pulsed operation but now we're going CW where's all the power to come from ?"

Few people had, as I had, forseen the problems which this machine would pose for us. The power came, in the end, from the national grid of course and every non-essential user was severely rationed.

"The lights are going out all over England," I said, "we shall not see them lit again for a long time."

In Part II, the author tells the inside story of the war as seen from the corridors of power in Whitehall. Later in the series he discusses the controversial direction of the Great Neutrino Experiments, including the much debated question of why the 23rd Applied Physics Division was not committed at a crucial stage in the battle. Most commentators have assumed that, in the fog of science, the Director General was not fully aware how close to collapse the enemy forces were. Quoting from his diaries, the author reveals for the first time the true reasons for these important decisions.

TEN COMMANDMENTS OF ELECTRICAL SAFETY

1. Beware of the lightning that lurks in an undischarged capacitor lest it cause thee to be bounded upon thy backside in a most ungentlemanly manner.
2. Cause thou the switch that supplies large quantities of juice to be opened and thusly tagged, so thy days may be long on this earthly vale of tears.
3. Prove to thyself that all circuits that radiateth and upon which thou worketh are grounded lest they lift thee to high frequency potential and cause thee to radiate also.
4. Take care thou useth the proper method when thou taketh the measure of high voltage circuits so that thou doth not incinerate both thee and the meter, for verily though thou hast no account number and can be easily replaced, the meter doth have one and as a consequence bringeth much woe upon the supply department.
5. Tarry thee not amongst those who engage in intentional shocks for they are surely non-believers and are not long for this world.
6. Take care thou tampereth not with interlocks and safety devices, for this will incureth the wrath of thy seniors and bringeth the fury of the safety officer down upon thy head and shoulders.
7. Work thee not on energized equipment, for if thou doeth, thy mates will surely be buying beers without thee and thy space at the bar will be filled by another.
8. Verily, verily I say unto thee, never service high voltage equipment alone, for electric cooking is a slothful process, and thou might sizzle in thy own fat for hours on end before thy Maker sees fit to end thy misery and drag thee into his fold.
9. Trifle thee not with radioactive tubes and substance lest thou commence to glow in the dark like a lightning bug.
10. Commit thee to memory the works of the prophets, which are written in the instruction books, which giveth the straight info. and which consoleth thee, and thou cannot make mistakes.

Anon.

Letters to the Editor

(Pseudonyms are accepted provided the author's name is known to the Editor.)

Sir,

A letter in the November issue of ORBIT complained of the additions, deletions and alterations needed to the Laboratory Telephone Directory. Since then we have had yet another long list of modifications. But this does not worry me much. It is better than a Directory six months out of date.

To my mind, a far more serious criticism is the simple fact that a high proportion of the Laboratory personnel never appear in the Directory. I refer of course to our Industrial people. What strange quirk in years gone by (in the class-ridden civil service ?) led to this state of affairs ? And why do we still stick to it ?

RING O

Sir,

One of the chief reasons for the "bad press" for High Energy Physics referred to by Dr. Stafford at the Staff Meeting is that when money is tight, people are apt to turn a jaundiced eye on "ivory towers", which is what a Laboratory such as ours must look like to most people. In the long run this is a very serious problem which can be solved only by pursuing legitimate scientific activities which are intelligible to the community at large. Apart from actually "communicating the excitement and interest of high energy physics" direct to the layman the most obvious activity of this kind is scientific teaching.

The question of the participation of research establishments in scientific education was aired in 1962 when the Robbins Committee was hearing evidence. The views of Dr. B. V. Bowden (as he was then) received a certain amount of publicity. As often happens with voices in the wilderness Lord Bowden (as he is now) has been asked to make straight the ways and would presumably view such developments favourably. What has happened is that the very unsatisfactory state of scientific education in this country has at last become apparent and may be expected to have considerable priority in the minds of those charged with the overall planning of civil science. It is also fairly clear that the long term economic health of the country depends very much on its ability to use its wits, particularly its scientific and technical wits. It seems that in entering into the field of scientific education we would be in the comfortable position of simultaneously fulfilling our duty to the community and serving our own need to get rid of the "ivory tower" image.

In determining who in the Rutherford Laboratory might do the teaching, assuming it is to be done, one could adopt the formula that one half of the graduate staff should devote half their time to it. On this basis the effective number of teachers is a quarter of the graduate staff. In the Rutherford Laboratory at present this gives something over twenty equivalent full time teachers. Now the physics staff of British Universities vary from giants like Imperial College (50+) down to Queen Elizabeth College (6). On the $\frac{1}{2} \times \frac{1}{2}$ basis we would be rather better staffed (in numerical terms) than Queen Mary College and rather worse than the University of Leeds. If this were to be a combined exercise with Culham Laboratory, say, or AERE we could mount a physics strength comparable with the largest departments in the country.

Should we be considering an actual physics department on the Laboratory site or an equivalent contribution to the national scientific teaching effort? In the first instance probably the latter, but at the same time the idea of basing a University on the site of a large scientific research installation should not be neglected.

As a first step in this process we could have conversations with the Universities of Oxford, Reading, Bristol, Southampton and London with a view to finding out where our potential could be most readily exploited. An examination of the arrangement which exists between Manchester and Risley would also be advantageous.

To sum up, this activity is a legitimate way of using scientific man-power, which would serve a genuine need and show that the Laboratory's interest in Science is not restricted exclusively to Pure Research.

T. R. Walsh.

Sir,

A number of people have been asking why it has taken so long to restore the floor in the Rotunda of the Restaurant. Your readers will be interested to know that a decision was taken some time ago to replace the existing wooden blocks but it was no use doing this until, a) the cause of the trouble had been determined and b) the best way of remedying it and of relaying the floor to ensure no recurrence had been agreed upon. Investigation into these problems necessarily took a long time.

We are confident that the causes are now known and that the correct remedial action can be taken. Materials have been ordered and preparatory work will commence almost immediately. The main work of relaying the floor is scheduled to begin on March 1st and will take 7 or 8 weeks. During this period service in the Rotunda will necessarily be restricted. The Restaurant Committee will be consulted about arrangements for operating the Restaurant service while the floor is being relaid and full details will be published in a Rutherford Laboratory Circular during February. Everything possible will be done to limit the inconvenience to users of the Restaurant but I regret that some restriction will be unavoidable.

W.W.Woodall

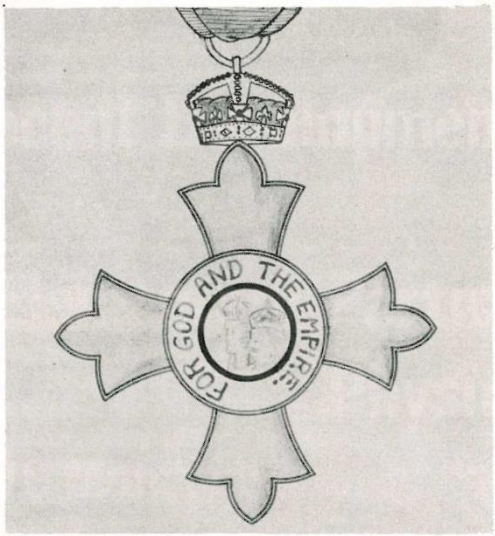
Oddest of All

Being a sequel to Something Odd (ORBIT, April 63)
and Something Even Odder (ORBIT, August 63).

"Come on! Look sharp man!"
"Oh dear, Oh dear! It's all right for you old chap, you're younger than I am. Running up hills is all in the day's work for you. Now perhaps you'll be good enough to explain why we're up here on the Mound."
"I want to show you something. Look over there at the so called Restaurant building. What do you see that's new ?"
"Well, er, only those new flower beds."
"Good. Good. And why have they been put there, radiating from the centre of the accelerator like that ?"
"Oh dear, Oh dear! Hearing you call it the accelerator still gives me a turn. I just can't get used to it."
"How difficult it is for small minds to break out of habitual thought matrices! You've just been conditioned to think of it as a Restaurant. The fact that everybody has lunch there has fooled you! Didn't the financial crisis it caused convince you ?"
"Well on the rational plane yes . . . but I just don't seem to Feel that it's an accelerator that's all."
"Feel!! Use your intelligence man, your powers of reasoning! Those flower beds have been put there to disguise the fact that the grass was changing colour. And the reason for that is simple - it was being irradiated along two narrow strips where their beam lines run. Don't you see what that means ? They've got the machine in commission!"
"It sounds so far fetched . . . ."
"Well, even you must have noticed something wrong with the wood block floor."
"Of course. Who hasn't noticed it. Dammed inconvenient."
"You must also have noticed that They are keeping quiet about the cause of it. We're told all about the remedy but not a dicky bird about the cause which is that the wood blocks are suffering from radiation damage."
"Oh but surely it's due to the underfloor heating . . . "
"Use your loaf man! Do you honestly think anybody would put underfloor heating in an expensive building and then pick the wrong wood blocks ? They must have gone into all that. What's the Wood Research Centre for ? The radiation damage has caught Them out. There's not much known about that subject."
"But it might be the heating . . . . ."
"Wood shrinks when it dries out man - it does doesn't expand. . . . . GET DOWN!"
"What . . ."
"DOWN."
"I say old man this grass is wet! What's the matter now ?"
"I saw the glint of binoculars in the direction of R1. I think They've spotted us. Come on. Crawl away on our stomachs. That's the thing -"
"Oh dear, Oh dear. I'm going to catch my death of cold doing this. . . . I wish I could be sure. . . ."

Dr. PICKAVANCE C.B.E.

We congratulate the Director of the Rutherford Laboratory on receiving the title of Commander of the British Empire in the New Year's Honours List.



Orders of Chivalry

by our Heraldic Correspondent

The Most Excellent Order of the British Empire is one of a number to which appointments are made in recognition of distinguished public services. The Orders of the Garter, Thistle and St. Patrick are the most ancient and the most exclusive. They are usually confined to peers. As in other fields, an exception was provided by Sir Winston Churchill when he was made a K.G. of which there cannot be more than 26 at any one time.

The majority of the other Orders were created to reward particular types of service, and are subdivided into various classes of membership. The Order of the Bath is usually confined to officers of the armed forces and senior civil servants, the Order of St. Michael and St. George is awarded for diplomatic services and the Royal Victorian Order is for personal services to the Sovereign. The Order of Merit and the Companionship of Honour are awarded to mark special distinction and are restricted in numbers to 24 and 65 respectively.

The Order of the British Empire was instituted in 1917. The number of annual appointments is limited although the total is not. At present there are over 30,000 members most of them of course in the lower classes of membership. There are five classes: Knights (or Dames) Grand Cross (C.B.E.); Knights (or Dames) Commander (K.B.E. or D.B.E.); Commanders (C.B.E.); Officers (O.B.E.) and Members (M.B.E.). Those in the first two classes are entitled to the style of Sir or Dame, though (as in other Orders) persons appointed Knights Grand Cross are usually Knights already, e.g. K.B.E. or Knight Bachelor (not attached to any Order). The British Empire Medal (B.E.M.) is not now part of the Order.

The Insignia of the Order of the British Empire has the form of a cross patonce, surmounted by a crown, and with a central medallion which includes the motto "For God and the Empire". In the case of Commanders the badge is of pearl grey enamel edged with gold, the central medallion being scarlet and gold. The ribbon is rose pink edged with pearl grey and suspends the badge around the neck of C.B.E's and on the left breast of O.B.E.'s and M.B.E.'s. The two highest grades have ornate breast stars and G.B.E.'s have a gold collar. We look forward to being able to illustrate these in the not too distant future.

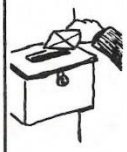
PERSONNEL NEWS

Comings and Goings

D B Gay, L J Humphries, C Lambert, R O'Toole, T J Prior, M J Rutter and D Trimm join Central Engineering.

F Lloyd, P O'Brien, C J Rosser, N S Vigeon, P D Roper and A T J Whittle join Nimrod Machine Engineering.

Miss S Norcliffe and G Waters join PLA Accelerator Physics; G R Ruffell joins PLA Nuclear Physics.



H Aldred, Mrs B I Hands and Miss F Knox join General Administration; Miss S Wills joins Atlas Operations.

P M Hunt joins Nimrod Machine Physics; P Rosser joins Variable Energy Cyclotron Group.

H Taylor joins Nimrod HEP Engineering; R E Chandler and R Lovelock join HEP Electronics.

Miss J E Robertson, W J Stark, A G Venn, Mrs J Griffiths, Mrs D Owen, J Gilbert, J D Nicholson, E Rudkin, Mrs J Mays, P Murtha, Mrs B Hammond, Mrs E M Rundle and D S James have left us.

K J Howard and E J Jones have been seconded to AERE for two years; J E Tomlinson has transferred to Daresbury; T D K Perry has been posted to CERN.

Bob Bennett of the Nimrod Beams Group has returned to New Zealand to take up a University post. Dave Warner of the PLA Accelerator Physics Group has taken a post in the MPS Division at CERN for three years.

Congratulations to

Miss Janet Robertson formerly of HEP Division on her engagement to Alan Bond of Imperial College, London. Janet has left the Rutherford Laboratory to take up teaching.

Mrs. Dorothy Owen, formerly of the NIRNS Secretariat, on the birth of a daughter, Emma Jane, on 10 January.

Suggestion Awards

At the twenty-third meeting of the Rutherford Laboratory Suggestion Awards Committee held on Wednesday 13 January the following awards were made:

£4 to R Sandford whose proposal to use an injector spray to add panacide to the cooling towers, has been adopted. It eliminates the safety hazard present with the old method, and also increases efficiency.

£2 to J Fraser who proposed modifications to the vent system for liquid hydrogen targets will be adopted.

An Encouragement Award of £1 was made to R Ross and two of 10s each to K T Gebhart and S Lewis.

B Briscoe, Secretary.

Record Programmes

Programmes will be held every Tuesday in February at 12.30 p.m. in the Lecture Theatre.

2 Feb:	Brahms	Symphony No.4
9 Feb:	Light Music	
	Elgar	March "Pomp and Circumstance No.1"
	Grieg	Peer Gynt Suite - Anitra's Dance; In the Hall of the Mountain King
	Chabrier	March Slave
16 Feb:	Trad. Jazz	
	Jazz from Kid Ory, Louis Armstrong and Johnny Dodds	
23 Feb:	Stravinsky	Petroushka

Retirement

Ernie Hester, Research Experimental Mechanic, retired on 29 January at the age of 66.

Since joining the Rutherford Laboratory in May, 1962, Ernie has worked in the Central Engineering Group, R.9, and has shown a very high degree of skill as a turner. His pleasant personality will be missed by all his colleagues.

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