orbit

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Journal of the Rutherford High Energy Laboratory

Why Pure Science?

Extracts from the address by Professor Weisskopf, Director General of CERN, on the occasion of the Press Visit to CERN, 19 May 1964.

Science is playing an ever-increasing role in our culture, in our life and in the economy of the world. Yet at the same time its results are becoming, for the layman, increasingly abstract and apparently further removed from everyday life. The amounts of money earmarked for pure science are of the order of a billion dollars a year, and the citizen has a right to ask the question : why pure science ? It is our aim here to defend one special kind of pure science : the branch of physics that looks for the fundamental constituents of matter.

Any intelligent discussion of the impact of pure science in our society must be based upon knowledge of the development of modern physics in our century and of the role of the study of elementary particles in the history of science in general. We shall divide the development of atomic research into three parts.

The electron shell

The first step in atomic research was to recognize the existence of the outer electron shell and to study its laws. The essential advance which made this possible was the conception of quantum theory. It is hardly too much to say that the quantum theory gave us the key to the understanding of most of the phenomena which surround us on earth, and therefore also, the tools to control them.

From a philosophical point of view, the knowledge of what goes on in the electron shell of the atom gave us a basis for the understanding of chemistry, i.e. a basis for the understanding of the constitution of all the substances which make up the world that surrounds us. It has also enabled us to understand electrical phenomena, the relation of matter with light, the colours of things and the emission and absorption of radiation. It also led to an understanding of production of energy by fire, electricity and chemical processes. It has also given us the key to the understanding of biology.

From a practical point of view, it is certain that every industrial activity today is affected in one way or another by atomic science; modern production of power is based on a thorough analysis of the underlying atomic processes. Electronics could not exist without a knowledge of the quantum nature of electron motion. Modern metallurgy makes use of the quantum structure of metals and the production of plastic materials would be impossible without modern quantum chemistry.

The nucleus

The internal properties of the atomic nucleus need not be known to understand the atomic phenomena which we have mentioned so far. The second period of atomic research concerned the nucleus. To understand the significance of this second step it is necessary to keep in mind a basic law of nature, a quantum law, which states that the smaller the object being studied, the higher must be the energy used to penetrate into that object. This law means that, for the study of atomic phenomena as we observe them in our environment, the structure of the nucleus itself is not important since, at the energies usually found on earth the nucleus is not involved. Physicists could approach the investigation of the structure of the nucleus only when sufficiently high energies became available to enable them to penetrate into the realm of very small dimensions. Such energies range from a hundred thousand to millions of electronvolts and the really systematic development of nuclear research only became possible when artificial particle accelerators of this energy level could be built. It was found that nuclei are composed of particles, namely protons and neutrons and that there exists a new kind of force keeping these two constituent parts together. The investigation of the structure of the nucleus proceeded as instruments became available. It became clear that the laws of quantum mechanics, which govern the electron shell, are also the laws of nuclear structure.

The philosophical significance of this second phase lies in the discovery of a new force in nature, and a new world of phenomena. The latter includes nuclear reactions, the transmutation of a nucleus of one element into one of another, the excited states of a nucleus, radioactive phenomena, artificial radioactivity, fission and fusion. Moreover, the study of nuclear processes led to an understanding of the history of the universe. It could be shown that the elements were formed in the centre of stars and in star explosions. The history of matter could be traced from an original hydrogen cloud to its present forms.

The practical side of all this is well known. In nuclear reactors, the fission of the nucleus has been turned into an outstandingly productive source of energy. It warrants the hope that the nuclear fusion process, which takes place in the stars, will also some day find a practical application. Furthermore, artificial radioactivity which was a consequence of this development has opened up a whole new field in medicine and in science as a whole, from biology to metallurgy.

Elementary particles

Now for the third stage of development. The nucleus consists of protons and neutrons. What do these elementary particles consist of? Because of the law already mentioned above, it is necessary to use substantially higher energies in order to penetrate into the structure of these particles. One can get a glimpse of the structure only if energies a thousand times higher than those required in the second stage are available. Consequently, it is necessary now to have machines which give us thousands of millions of electronvolts. There is a natural source of energy of this order of magnitude – cosmic radiation. But cosmic radiation is too dispersed and too difficult to control to be useful as a systematic tool of research. Accelerator techniques, on the other hand, have been developed to such an extent that they can provide thousands of millions of electronvolts. From a technical point of view there seems to be no reason why one should not be able to build accelerators producing a hundred thousand million or one million million electronvolts.

One cannot furnish a systematic description of the outcome of this third stage of research because we are still at the beginning. We are still unable to formulate the results in a simple way; we cannot as yet assess their full philosophical and practical significance. Nevertheless, it seems obvious that, from the "philosophical" point of view some very great perspectives are opening up. We are beginning to understand the real nature of the nuclear force. We are faced with entirely new phenomena and are perhaps approaching what might be called the primeval history of matter. We are now approaching the problem of the fundamental structure of matter. Perhaps such research will produce answers to the major questions that are still unanswered: the expansion of the universe, gravitation, the origin of matter. We cannot, at this stage, speak of practical applications; they are still remote. All we can offer at the moment is a description of phenomena – not a systematic classification,

certainly not yet an explanation or a formulation.

Particle phenomena

The phenomena may be divided, somewhat arbitrarily, into four groups. The first is concerned with nuclear force quanta. Just as there are quanta of light, the quanta of electro-magnetic force, there are also quanta of nuclear force. They have been found and are called mesons. Their properties, the way in which they are emitted and absorbed and allied matters, now lie at the centre of our research.

The second group concerns the higher, excited states of the protons and neutrons. When these are subjected to very high energies, they pass into states of higher energy, remain there for some time and then return to their ground state, like atoms. In doing this they emit a characteristic radiation which in most cases is not light but is mesonic radiation. We may, in this connection, speak of a third spectroscopy – the first being atomic and molecular, the second nuclear, and the third that of the nucleons or elementary particles.

The third category is connected with antimatter. By using the high energies now at our disposal it is possible to turn energy into matter. In the course of these transmutations it has become apparent that matter can only be produced together with anti-matter. Antimatter does not differ from matter in any respect except that its pattern is reversed. The nuclei are negative instead of positive, the electrons are positive instead of negative; all the constants, including the nuclear force constants, are reversed. The picture as a whole is not very different from that of ordinary matter. But what is interesting is that when brought together, antimatter and matter turn back into energy of a very special kind, namely nuclear force quanta.

One of the most interesting fields of research, which concerns the fourth category, promises much for the future. It is the field of weak interactions. The usual radioactive decay, the beta decay, is the best-known example of a so-called weak interaction. It is a process which takes place in the nucleus, whereby a neutron is transformed into a proton and in so doing releases an electron and a so-called neutrino, that mysterious particle without charge or mass. All weak interactions seem to have a similar character. They are the interactions of electrons and neutrinos with neutrons and protons. It has been found that these electrons and neutrinos may, in some ways, be linked together and indeed may only be two different forms of the same particle, the so-called lepton. Furthermore, we have discovered that there is a heavy electron known as the muon which differs from the ordinary electron exclusively by its mass but is short-lived and decays into the ordinary electron. None of these phenomena is yet quite clear, and we may be faced here with a new force.

This is the briefest outline of some of the phenomena which appear in the third and latest phase of atomic research. It is clear that we are at the very beginning of this development which is going to be most extensive. The energy now available, about thirty billion electronvolts, is just enough to produce the excited states of the nucleons and just enough to produce nuclear force quanta; for the so-called weak interaction experiments it is close to the lower limit. The energies at our disposal are simply too small to probe into these very short distances and accelerators of much higher energy will have to be built before really striking progress can be achieved in this new field.

The future machines

One might now ask: is there any real sense in building ever larger machines? Perhaps we shall again discover particles of particles so that we shall have to build accelerators of yet higher energies to investigate the structure of those particles of particles. Is there an end to this process? That is a very difficult question to answer. Perhaps the time to stop is when the field will cease to be interesting. If we are very clever and very lucky, the discoveries made with the present machines and with the next "generation" of machines may enable us to discover a basic law of nature to explain all phenomena. Then probably, yet another generation of accelerators will be needed to prove that conclusion. If we understand everything, the field will lose its interest: it will be closed. On the other hand, we may never be able to understand everything. In that case either we would continue to find new phenomena which would be interesting, and we probably ought then to be prepared to go further and further still; or no new phenomena of significance appear, and this would be uninteresting.

The question of money

The practical side of the question is, of course, the question of money. Should a government be responsible for spending so much money on such a pursuit? Why devote money to fundamental research? Basic and fundamental ideas are not those which have practical applications. but the ideas and methods which develop from fundamental discoveries are the elements which bring about technical progress.

Today the totality of pure research, not only high-energy physics, absorbs about one-third of one per

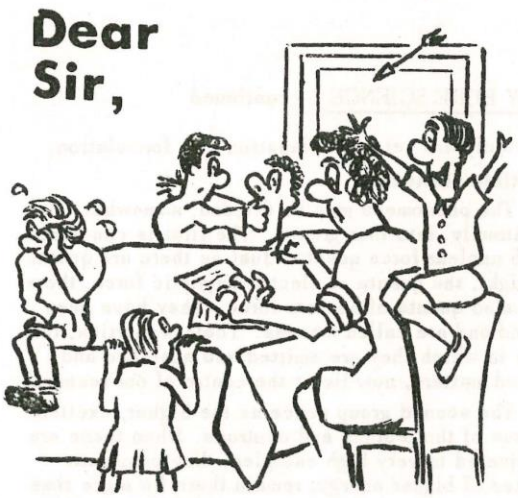
WHY PURE SCIENCE? - continued

cent of the gross national product in America and almost as much in both France and England. One-third of one per cent of the gross national product is a small percentage representing about $2000 million in the USA and $1000 million in Western Europe. This is less than 10% of the yearly growth of the gross national product. It is interesting to contemplate that the total expense for basic science from Galileo to the present time is not more than the increase of the world's production in one year. In ten years, the gross national income is bound to increase by 40 per cent or more. The percentage devoted to pure research is also going to increase, since the number of scientists grows steadily and the scientific methods are getting more involved and more complicated. One should therefore expect at least twice as much money to be spent on pure research in ten years from now.

High-energy physics is a relatively new part of basic physics which is now in a state of rapid development. It aims directly at the most fundamental questions of the basic laws governing the structure of matter and the universe. The scientists working in high-energy physics cannot help the fact that their instruments are more expensive than the means of research in most other fields of basic science. They are, after all, investigating matter under most unusual circumstances. Is it then asking too much if the physicists request a substantial increase in financial support for this field of activity?

The cost of high-energy physics is in fact not as high as one might believe. Western Europe spends today (1963) about $80 million per annum and the USA about $200 million. Assuming that the plans for new machines are approved, that these machines are built and that ancillary equipment to exploit them and to train physicists in the universities is available, what would the yearly expenditure be when the programme is in full swing? Expenses reach a kind of plateau and in ten years the European plans would require about $250 million and the American plans about $500 million per year. This rate of expenditure for high-energy physics would amount to not more than twelve per cent of the expected total expense for pure research, a percentage that does not seem extravagant.

Fundamental research sets the standards of modern scientific thought; it creates the intellectual climate in which our modern civilization flourishes. It pumps the life-blood of ideas and inventiveness not only into the technological laboratories and factories, but into every cultural activity of our time. The case for generous support for pure and fundamental science is as simple as that. A small part only of a nation's total income is needed to keep fundamental research in full swing. It would be wrong to try to save a fraction of this small part if such savings weakened the most vital and active part of our intellectual life, the part which we all should regard with pride as one of the highest achievements of our century.



A few months ago we presented extracts from car accident reports. We have now gathered, via AWRE News, some risque, but genuine, extracts from letters written to the offices of the Ministry of Pensions and National Insurance.

This is my eighth child. What are you going to do about it?

Mrs. R. has no clothes and has not had any for a year. The Clergy have been visiting her.

In reply to your letter. I have already co-habited with your office, so far without result.

I am forwarding my marriage certificate, and two children, one of which is a mistake – as you see.

Unless I get my husband's money, I shall be forced to lead an immortal life.

I am sending you my marriage certificate and six children. I had seven and one died, which was baptised on a half a sheet of paper by the Rev. Thomas.

Please find out if my husband is dead, as the man I am now living with won't eat or do anything until he is sure.

In answer to your letter. I have given birth to a little boy weighing ten pounds. Is this satisfactory?

You have changed my little girl into a little boy. Will this make any difference?

Please send my money at once as I have fallen into errors with my landlord.

I have no children as my husband is a bus driver and works all day and night.

In accordance with your instructions, I have given birth to twins in the enclosed envelope.

I want money as quick as you can send it. I have been in bed with doctor all the week and he does not seem to be doing me any good.

Re your enquiry. The teeth in the top are alright, but the ones in my bottom are hurting horribly.

Milk is wanted for my baby as the father is unable to supply it.

The Accelerator World

Beam from Oxford Tandem

The tandem accelerator of the Oxford project transmitted its first beam on June 25th: a measurable current has been registered at the high energy end. Installation of the machine commenced on January 20th, and commissioning of the machine by its manufacturers (High Voltage Engineering Company) as a generator was completed in early May, when the design voltage of 6 million volts on the centre terminal was achieved. The tandem ion source, a NIRNS/Oxford project, has given a maximum of 29 microamperes of resolved H^- beam : the beam bending magnet is fully commissioned, and accurately calibrated with alpha particles : installation of target flight lines is in progress.

As regards the vertical 8 million volt injector, the tower is approaching completion, and the commissioning of the first installed item, the annular lift platform, is proceeding.

Foundation Stone Laid at Daresbury

The Daresbury Nuclear Physics Laboratory had its first formal occasion on Tuesday 16 June when a foundation stone was set in the entrance to the partially built laboratory and office block. The ceremony was performed by the Chairman of the National Institute, the Rt. Hon. Lord Bridges, in the presence of the Laboratory's staff and visitors representing the Rutherford Laboratory, the Universities, the Atomic Energy Authority, the Main Contractors, the Local Authorities and other interested people. In a brief speech Lord Bridges commented on the tremendous progress that had been made. He recalled the time when the staff of the Laboratory, "numbered one, part time!" The Director of the Laboratory, Professor Merrison presented Lord Bridges with the stonemason's mallet which had used to set the stone and also a photograph album containing photographs taken at monthly intervals since the project began. This album will be added to as the construction continues.

The weather was kind throughout the day and before the actual ceremony most of the visitors were taken to lunch at the Neptune Moorings at nearby Preston Brook. The journey to and from the meal was by boat along the Bridgewater Canal, which gave a Venetian touch of novelty to the occasion. (The organisers of the venture are reasonably confident that no-one was lost on either journey and not even "mal de canal" was apparent).

Meeting of CERN Council

The 27th Session of the CERN Council was held on 18 and 19 June. Professor Weisskopf, Director General, reported on the recent work at CERN covering the latest discoveries of meson resonances; the search for the hypothetical particles ('quarks') carrying a fraction of electric charge (no evidence was found for these); the neutrino investigations into weak interaction theory.

Discussion on the future European programme dominated the Session. The President of the Council, Mr. J.H. Bannier (Netherlands) invited the delegates from the thirteen member countries to make such recommendations to their Governments as would permit the Council to make a decision on the proposal to build storage rings at the CERN 28 GeV proton Synchrotron, if possible in December 1964. A decision on the proposal for a 300 GeV proton synchrotron would be desirable by the end of 1966. In the meantime, member countries are invited to submit proposals for possible sites on which the large accelerator could be constructed.

EDITORIAL

For over a decade high energy physics has been riding the crest of a wave. Recently, however, there have been signs that the wave will not continue to surge forward at the same rate. In Britain, the last Annual Report of the Advisory Council on Scientific Policy (ACSP) was not favourable to us and several Ministerial comments have been unenthusiastic for the next generation of accelerators being on a European scale. In America, for the first time ever in May of this year, the Atomic Energy Committee cut back the requested $94.5 million by $1.8 million – a small but symbolic amount – and they have already turned down the MURA machine recommended in the Ramsey Report on the next phase of American accelerators.

Several rocks menace the progress of the wave. Governments are apprehensive at the ever increasing cost of our research and probably too, at the growing commitment of scientific and engineering manpower. Scientists go forth from the accelerators to teach in the Universities and multiply their kind, creating a need for new accelerators which sustain the growth rate and so on.

Other disciplines in the scientific community are apprehensive at our apparent preference and no doubt jealous that we have it so good. Newer areas of interest call for support but probably haven't the strong lobby to present their case that we have to present ours.

Outside the scientific community we are probably seen as part of the burden on the world's resources which includes such profligate spenders as defence programmes and space research.

There are answers to these objections and most of them are given in Professor Weisskopf's speech which takes up a large part of this issue. But the facts remain that we are asking society to make a collosal contribution to support our work and that we seem to be losing their sympathy.

This may be partly due to the way we so often present our case. In the first place it does not always help to minimise the apparent size of the contribution by using the gross national product as the basis for comparison. To take one alternative, if the comparison were made with the total expenditure on all forms of the Arts, the size of our request would seem much more significant.

We are one branch (high energy physics) of one branch (physics) of one branch (science) of human activity. We are a luxury, albeit one which enriches human culture and one which may possibly benefit man's material wellbeing in years to come. Our case will probably be listened to much more readily if more awareness of this is shown.

The following quotations relevant to this theme have been collected in recent months –

'The scientific case for Europe continuing forcefully in high energy physics is overwhelming; the equipment needed is technically feasible; the scientific manpower needed will be available; the money is trivial. Only conservatism or timidity will stop it.'

M.G.N. Hine 'Financing High Energy Physics'
15 May 1964.

'The overriding need is that the physicists who seek this great boon of European society should make their case in public whenever they have the opportunity. All too frequently their arguments are marred by the assumption that the world owes them a living. This, in the long run, may be true but in the real world of competing claims for limited national resources no speciality can hope to find that its path is paved with roses.'

John Maddox 'The Guardian'
26 May 1964.

'There will be more than enough work for two machines of 300 GeV energy. In fact concerning the proposal for a 200 GeV machine at Berkeley, the Americans are already wondering whether this should be regarded as an American machine or as a Californian machine.'

Heard at the CERN Press Day
19 May 1964.

'To avoid duplication of effort and misuse of money and scientific manpower, every effort should be made by Governments, first to co-ordinate efforts in nuclear physics and to seek full international co-operation now, before beginning construction of a 300 GeV machine.'

ACSP Annual Report
31 October 1963.

'You know what we call the ACSP here? The Association of Chemists for the Suppression of Physicists.'

Heard at the CERN Press Day
19 May 1964.

'The glamour of the spectacular in science is distracting our attention from the prosaic necessities of contriving how 3,000 million people today and 4,000 million by 1980 can exist on this globe of ours.'

Professor Ritchie Calder
'The Future of Science'
De La Rue Journal, 1963.

'The whole of scientific knowledge, on which western civilisation is based, and which is the essential key to industrial and social progress has cost less than one year's growth in the production it has made possible.'

M.G.N. Hine 'Financing High Energy Physics'
17 May 1964.

'The decision to put some human beings into space can only be taken at the expense of an implied counter-decision to let millions more die earlier.'

Harvey Wheeler
'The Challenge of Bureaucratized Science'
Bulletin of Atomic Scientists January 1964.

EDITORIAL - continued.

'Nuclear physicists have been brought up sharply against the recognition that even in their esoteric branch of science, it is necessary to cut the coat to fit the cloth. The fact that there is such a rich prize to be won in the near future is not in itself a sufficient justification for spending the large sums of money that will be needed.'

John Maddox 'The Guardian'
26 May 1964.

With this issue, we enter the third year of publication of ORBIT and as a modest celebration have changed the layout of our front page. Several months ago we asked for suggestions for rearranging our cover while still staying within our financial allowance and still giving most of the page to text. The design we have adopted is based on suggestions from Leslie Haddow (AERE) and Mike Harold. It is a very encouraging indication of the interest in the Journal that about fifty designs were sent in. We would like to thank all those who offered their ideas and we continue to be thankful for the excellent co-operation we have from almost all areas of the Laboratory.

At the end of our first year we added an index of the year's articles since several people, using ORBIT as their reference source of information on Laboratory projects and on extra-mural events, had requested it. This year we are not publishing a full index in every copy but the Laboratory Library will hold a bound, full set of ORBIT's complete with index for the two years.

One disappointment of the past few months has been our failure, because of lack of time and effort, to sustain the series of articles on Fundamental Particles which we hoped would be one of the most worthwhile functions the Journal would perform in the current year. Only one article, in the March issue, has appeared but we haven't given up hope of resuming them in the future. The article on the arrival of the Saclay Bubble Chamber is held over until next month.

We hope that the Journal will continue to find its way into your hands for as long as it serves a useful purpose. We try to ensure that it informs of the progress of our projects and of relevant developments outside; that it entertains with its stories, tenuously related to Laboratory life and that, sometimes, it provokes thought about what we are doing and why. We hope that we never become so set in our ways that the Journal becomes boring. Oscar Wilde once said, 'The British public can deal seriously with only two topics of conversation at any one time. One of these is always the weather and the other is usually the Royal Family.' Neither of these topics has received more than a casual mention in ORBIT. When they do, it will be time to reconsider publication.

'Physics leads straight to Administration' – Professor Bernard Gregory, CERN Directorate Member for Research. Such a thought may seem to smack of disillusionment. But in fact, it probably reflects not only the state of mind of the 'chief', on whom falls the burden of making the vital decisions concerning the future as much as the present, but also that of the contemporary research scientist. In experimental nuclear physics, the era of great discoveries by a single person using primitive equipment is well and truly over. Since the War, the emphasis has been on 'large scale physics' using enormous machines costing millions to run. There are few of these machines, and it is all the more necessary to ensure their intensive exploitation with a minimum of lost time. For the physicist who is somewhat of an idealist by nature this means a sudden transfer to the planned atmosphere of the big laboratories where the relatively rigid organisation may seem synonomous with administration carried to extremes.'

CERN Courier.

'The annual number of published papers reporting experimental results in the field of nuclear structure ... is such that ... the nuclear structure physicist of the year 5274 A.D. will have to spend his entire working day (18 hours), 300 days per year, reading at the rate of 1,200 words per minute to cover his field ... unless he uses an information centre.'

N.B. Grove
'Information Centres in Nuclear Physics'
Physics Today, Jan. 1964.

'... who can encompass the knowledge which is growing so rapidly? Every year three million original papers are released. Even the specialists in the fields cannot cope with the esoterics of their own subjects. Judgement is being drowned in a Niagra of information which, in terms of human values, no one can evaluate.'

'The Future of Science'
Professor Ritchie Calder
De La Rue Journal

Letters to the Editor

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

EDITOR : B. Southworth,
National Institute for Research in Nuclear Science,
Room 40, Building R 20,
Rutherford High Energy Laboratory,
Chilton, Didcot, Berkshire.

Sir,

Many of your readers must have been shocked and distressed to learn from a letter in June's ORBIT that the Laboratory had suffered great loss by the passing away of a number of its more eminent brethren.

However I am glad to be able to tell you that this appears to be a rumour without foundation as I have been assured, by a member of the staff of the right degree, that these same eminent people have actually been seen in the flesh at a recent Garden Party.

I hope others will be as comforted as I am to learn that when the necessity arises the togetherness of our great Institute is clearly shown to exist in the usual way observed among Freemen.

Yours humbly,

A SERF.

Afternoon Out

Uffington Castle

Uffington Castle is an historic hill fort which is now preserved and maintained by the Ministry of Works. It is probably already well known to many at the Laboratory and these few words are directed to those who are newcomers to the area or who have not yet paid it a visit.

The hill is about 8 miles west of Wantage, its steep sides standing sentinel over the peaceful Vale of the White Horse to the north. The valley takes its name from the large White Horse carved into the chalk hillside, which resembles a horse only because it appears to have the basic elements of this noble animal – a head, four legs, and a tail.

There have been prolonged arguments among learned people as to its exact origin but most local people are pleased to accept its association with King Alfred and the Saxons. Certainly, the Saxons used the White Horse emblem on their battle flags and doubtless such simple bold outlines as those on White Horse Hill were easy to copy on flags or shields. (Incidentally the Red Dragon of Wales is said to have originated from the Roman battle flag carried by the Roman foreign auxiliaries).

The Castle is a large, roughly circular earthwork, the outline of its parapet, ditch and ramparts being easy to recognise. It is even possible to surmise where the entrances were. The top of the earth wall used to be surmounted by a wooden pallisade, while the ditch would probably have been liberally supplied with pointed stakes to add to the discomfort of any would-be attackers and take the momentum from any forward rush. This would enable those within to drop stones on the unfortunate foe; give vital time to reload bows, or to move reinforcements to any threatened breach.

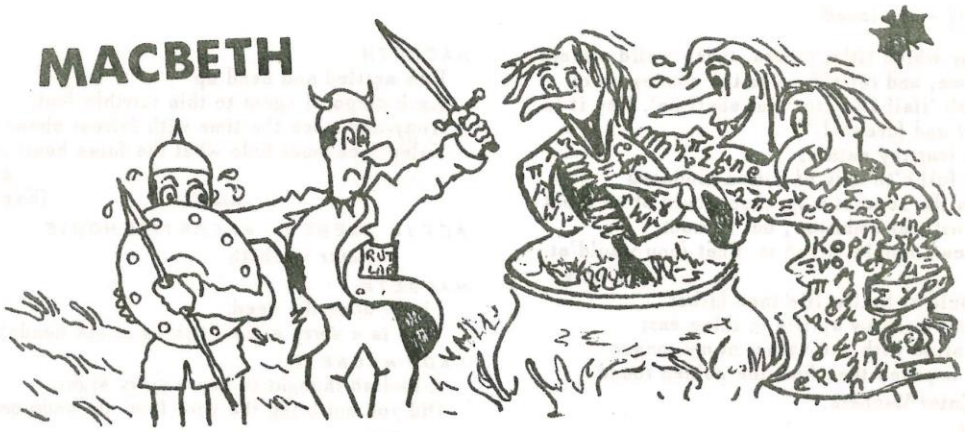
The detailed accuracy of this picture is not important, but it adds to the pleasure of a visit to such a site to recreate those scenes of long ago.

On the other hand we are not all so imaginative, or even wish to be, and yet even so, the Castle is still worth a visit. As a picnic spot it is a firm favourite, with plenty of room for children to run around the mound, for Mum and Dad to take it easy, and for the older folk (if the climb proves too much) to admire the view from the car park near the top.

How to get there : From Wantage by car – follow B 4507 west towards Kingston Lisle. After about 8 miles a signpost indicates left up a steep climb to the car park at the top.

On foot – use Ordnance Survey Map No.158. Destination is map reference 300865 – the walk along the Ridgeway is rewarding.

MACBETH



ACT I SCENE I – A BLASTED HEATH IN BERKSHIRE.

Thunder and lightning. Enter three witches.

ALL
Fair is foul, and foul is fair,
Hover through the fog and filthy air.
Enter Macbeth

MACBETH
Speak if you can. What are you?

FIRST WITCH
All hail Macbeth! Hail to thee Section Leader!

SECOND WITCH
All hail Macbeth! Hail to thee Division Head!

THIRD WITCH
All hail Macbeth! That shalt be Director hereafter!

MACBETH
Stay you imperfect speakers, tell me more;
By promotion I know I am Section Leader;
But how Division Head? The Division Head lives
A prosperous gentleman and to be Director
Stands not within the prospect of belief,
No more than to be Division Head. Say from whence
You owe this strange intelligence. Speak I charge you!
(Witches vanish)

Enter Ross and Angus

ROSS
The Director hath happily received
Macbeth, the news of thy success at CERN.
He bade me, from him, call thee Division Head;
In which addition, hail, most worthy thane
For it is thine.

MACBETH (aside)
Section Leader to Division Head!
The greatest is behind! (to Ross and Angus)
The Division Head still lives. Why do you dress
Me in borrowed robes?

ANGUS
Who was the Head lives yet,
But under heavy judgement bears that life
Which he deserves to loose. He was discov'r'd,
His projects foundering in a sea of
Troubles, playing golf. Merrily with club
And ball, he trod the greens, oft revelling
At the nineteenth hole, the live long night with
Many a tale of hole in one. And these passions
Confessed and proved, have o'erthrown him.

SCENE II – A CONFERENCE ROOM IN R 1.

Flourish. Enter Director, Malcolm, Macbeth and Staff.

DIRECTOR
Sons, kinsmen, thanes,
And those whose places are the nearest, know,
We will establish our estate upon
Our colleague, Malcolm; whom we name hereafter
The Deputy Director.

MACBETH
Deputy Director! That is a step
On which I must fall down, or else o'er leap
For in my way it lies. Stars hide your fires,
Let not light see my black and deep desires.
(Exit)

DIRECTOR
He is full so valiant;
And in his commendations I am fed –
It is a banquet to me. Let's after him,
Whose care has gone before to bid us welcome.
(Flourish, Exeunt)

SCENE III – A ROOM IN A NIRNS HOUSE.

Enter Lady Macbeth alone with a letter.

LADY MACBETH (reads)
"They met me in the day of success and they have more in them than mortal knowledge. Missives from the Director came and hailed me 'Division

---

THERE ARE TWO KINDS OF FOOL. ONE SAYS, 'THIS IS OLD, THEREFORE IT IS GOOD.' THE OTHER SAYS, 'THIS IS NEW, THEREFORE IT IS BETTER.'

DEAN INGE.

Head', by which title, before, these weird sisters saluted me, and refer'd me to the coming on of time, with 'Hail Director that shall be'. Lay it to thy heart and farewell.'
Yet I do fear thy nature;
It is too full o'th'milk of human kindness
To catch the nearest way; thou would'st be great
Are not without ambition; but without
The illness should attend it. What thou would'st highly,
Thou would'st holily. Hie thee hither
That I may pour my spirits in thine ear;
And chastise with the valour of my tongue
All that impedes thee from the golden round.

Enter Macbeth.

MACBETH
My dearest love
The Director comes here tonight.

LADY MACBETH
And when goes hence?

MACBETH
Tomorrow as he purposes.

LADY MACBETH
O never shall sun that morrow see!
Your face, my thane, is as a book where men
May read strange matters; only look up clear,
To alter favour ever is to fear.
Leave the rest to me. (Exeunt)

SCENE IV - THE SAME

Enter Macbeth and Lady Macbeth

MACBETH
We will proceed no further in this business:
He hath honoured me of late, and I have bought
Golden opinions from all sorts of people.

LADY MACBETH
What beast was't then
That made you break this enterprise to me?
When you dur'st do it, then you were a man!

MACBETH
If we should fail?

LADY MACBETH
We fail:
But screw your courage to the sticking-place
And we'll not fail. When the Director sleeps
Take this wire and short circuit his electric
Blanket and, on his death, remove the wire.
Thus shall it appear that he, being tired
And o'erworked with great responsibility
His heart hath failed. Who dares to take it other,
As we shall make our griefs and clamour roar
Upon his death.

MACBETH
I am settled and bend up
Each corporal agent to this terrible feat.
Away and mock the time with fairest show:
False face must hide what the false heart doth know.
(Exeunt)

ACT II SCENE I - MACBETH'S HOUSE

Enter Macbeth

MACBETH
I have done the deed.
This is a sorry sight (looking at his hands)

LADY MACBETH
A foolish thought to say a sorry sight.
Did you not bring the wire from his bedroom?

MACBETH
I'll go no more.
I am afraid to think what I have done.

LADY MACBETH
Infirm of purpose!
I will fetch the wire! The sleeping and the dead
Are but as pictures. 'Tis the eye of childhood
That fears the painted devil. (Exeunt)

SCENE II - AN OFFICE IN R 1.

Enter Malcolm and Macduff.

MALCOLM
Macbeth thou hast it now - Directorship!
And I fear thou played most foully for it!
This murderous shaft that's shot, hath not yet
Lighted good Macduff and our safest way
Is to avoid the aim. Therefore to car
And let us not be dainty of leave-taking.
(Exeunt)

ACT III SCENE I - A CAVERN.

In the middle, a cauldron boiling.
Thunder. Enter three Witches.

FIRST WITCH
By the pricking of my thumbs
Something wicked this way comes.

Enter Macbeth

MACBETH
How now, you secret, black and midnight hags?

Thunder. Enter First Apparition: a workman carrying a new office name plate 'MACDUFF - DEPUTY DIRECTOR'

FIRST APPARITION
Macbeth! Macbeth! Macbeth! Beware Macduff.
Beware the Senior Group leader - enough.
(Descends)

Thunder. Enter Second Apparition: a

'I KNOW WHAT YOU MEAN' HE SAID, 'WE SAY THAT THE CAMEL IS A HORSE DESIGNED BY A COMMITTEE.'

GUARDIAN 7 JULY.

in ceremonial robes with a scroll of the Royal Society.

SECOND APPARITION
Macbeth! Macbeth! Macbeth!
Be bloody, bold and resolute; consider less
The power of man, for none but FRS
Shall harm Macbeth.
(Descends)

MACBETH
Then live Macduff, what need I fear of thee?
Thunder. Enter Third Apparition : a technician crowned with a device of intersecting rings.

THIRD APPARITION
Be lion-mettled, proud, and take no care
Who chafes, who frets, or where conspirers are:
Macbeth shall never vanquished be
Till Storage Rings to Rutherford do come.

MACBETH
That will never be!
Yet my heart throbs to know one thing – tell me
Shall Malcolm's issue ever run this Lab?

ALL
Show his eyes and grieve his heart
Come like shadows, so depart.
A show of eight Directors, each carrying a Nobel Prize, the Director's Ghost following, cloaked in his electric blanket.

MACBETH
Filthy hags!
Why do you show me this? – A fourth? – Start eyes!
What will the line stretch out to th'crack of doom?
Another yet? – a seventh? – I'll see no more!
(Witches vanish)
Where are they? Gone? Let this pernicious hour
Stand aye accursèd in the calendar!
Come in without there!
Enter Lennox

LENNOX
My Lord, I bring you word
Malcolm and Macduff are fled to CERN.

MACBETH
Time thou anticipatest my dread exploits:
From this moment, the very firstlings of my
Heart shall be the firstlings of my hand.
And even now, the Groups of Malcolm and Macduff
I will o'ertake, seize their results and
Publish as my own. No boasting like a fool
This deed I'll do before this purpose cool.
(Exeunt)

SCENE II – MACBETH'S OFFICE SUITE IN R1
Enter Macbeth and Staff.

MACBETH
Bring me no more reports: let them fly all:
Till Storage Rings to Chilton, near Didcot, come
I cannot taint with fear. What's the boy Malcolm?
Has he an FRS?
Enter First Messenger.
What news more?

FIRST MESSENGER
Gracious my Lord,
I should report that which I say I saw
But know not how to do it. As I stood
Watch upon the hill, I looked towards A 34
And anon me thought a Pickford's truck did
Move towards the Lab., with many a grinding gear,
And thereon I saw a huge packing case,
Emblazoned on its side a coat of arms,
With motto bold – 'Model Storage Rings for NIRNS'
Enter Second Messenger

SECOND MESSENGER
My Lord, Malcolm and Macduff
Have returned with a strong force and even now
Have taken Nimrod.

MACBETH
Arm! Arm! And out!
Ring the site alarm – blow, wind! Come, wrack!
At least we'll die with harness on our back!
(Exeunt)

SCENE III – A TUNNEL UNDER NIMROD
Enter Macbeth and Young Seward

MACBETH
My name's Macbeth.

YOUNG SEWARD
The devil himself could not pronounce a title
More hateful to mine ears.
(they fight and Young Seward is slain)

MACBETH
FRS thou had not!
But swords I smile at, whatever be the stress,
Brandished by man without an FRS.
(Exit)

Alarums. Enter Macduff.

MACDUFF
That way the noise is: Tyrant show thy face!
Let me find him, fortune! More I beg not.
(Exeunt. Alarum)

SCENE IV – THE MAGNET ROOM
Enter Macbeth and Macduff

MACDUFF
Turn, hell-hound!

MACBETH
Let thy blade fall on vulnerable crests,
I bear a charmed life, which must not yield,
Except to Royal Fellow.

MACDUFF
Despair thy charm,

'LIFE WITHOUT AN OCCUPATION IS CONTEMPTIBLE AND MEANINGLESS. BUT ALWAYS REMEMBER THIS – YOU MUST NEVER ALLOW YOUR OCCUPATION TO DEGENERATE INTO WORK.'

ROMAN BUREAUCRAT TO HIS SON.
'THE ITALIANS' LUIGI BARZINI.

MACBETH – continued

Acceleration high and beams fantastical,
With myriad particles both strange
And heavy, have earned for me an F R S.
Gaze on this telegram, Macbeth, which doth
Confirm my name in this year's list.

MACBETH
Before my body
I throw my warlike shield, lay on Macduff
And damned be him that first cries 'Hold, enough'.
(Exit fighting. Retreat)

Flourish. Enter with drum and colours,
Malcolm and Staff

MALCOLM
Macduff is missing
Enter Macduff with Macbeth's head.

MACDUFF
Hail Director, for so thou art. Behold where stands
Th'usurper's curs'd head: The time is free!

ALL
Hail, Rutherford Director!
(Flourish. Exeunt)

Personnel News

Record Society

Requests for music to be played at these programmes may be directed to Ron Hazell, R 25. The August programmes, beginning at 12.30 in the Lecture Theatre, are as follows :–

11 August

Overture	'The Mikado'
Prokofiev	Symphony No. 1 ('Classical')
Jacques Loussier	'Play Bach No. 1'

25 August

Overture and three vocal items from stage musicals

Handel	'Arrival of the Queen of Sheba'
Purcell/Clarke	'Trumpet Voluntary'
Armstrong, Hines	'Weather Bird'
Braff, Larkins	'In a Mountain Greenery'

Comings and Goings

A.J. Davis, G. Burbedge and A. Bishop join Bubble Chamber Group; J.E. Harris joins Bubble Chamber Group (C E R N).

D.W. Lucas, R.L. Chitty and B.F. O'Regan join Central Engineering; R.C. Hack joins Radiological Protection Group.

Mrs. M.C. Gould and Miss M. Little join Administration.

A.J.J. O'Connell joins H E P Engineering; H.E. Clark joins Nimrod Machine Engineering.

Mrs. J.A. Allenby and M.R. Bird join Atlas Laboratory.

W. Boyd, T.L. Collins, A.R. Kimber, B.J. Sutton, J.W. Hardie and R. Stanbrook have left us.

G. Lewis and H. Pascoe have retired.

Dr. D.J. Clark has completed his fixed term appointment.

E. Lindley has completed his period of secondment from A E R E.

Congratulations to –

Alan Carne, P L A Accelerator Physics, and his wife Diana, on the birth of a son, David Simeon on 21 June.

John Timmins, Radiation Protection Group, and his wife Sylvia, on the birth of a daughter, Nicola Susan, on 5 July.

Dance Club

It has been suggested that a dance club be formed at the Laboratory. The aim would be to start programmes in the Autumn to be held on one evening a week with possibly two periods an evening.

No firm ideas as to what would be required in an evening's programme (e.g. what percentage of time to give to instruction) have been worked out at present. Suggestions from interested people should be directed to –

D.A. CRAGG Ext. 6276.
P. McKAY Ext. 549.

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