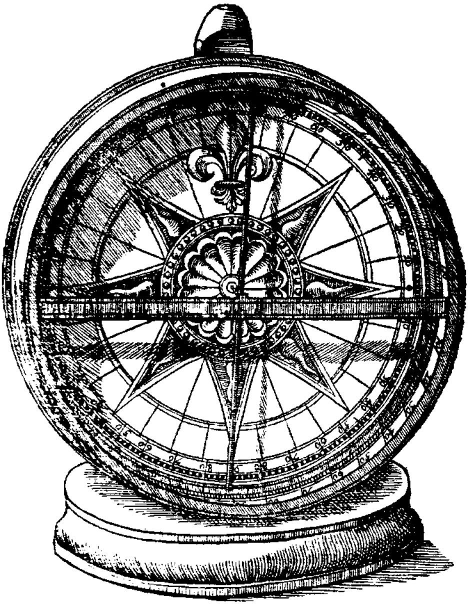
HISTORY OF PHYSICS GROUP



NEWSLETTER

No. 8 SPRING 1994

A DECADE OF HISTORY

BECAUSE IT IS THERE - AND I AM CURIOUS

INDEX OF ARTICLES OF HISTORICAL INTEREST

THE INSTITUTE OF PHYSICS

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Lateral Thoughts, Alan Morton, Physics World, I.O.P., November 1993

EDITORIAL

It is 10 years since the formation of the History of Physics Group. The background to its setting up and subsequent development is illustrated by John Roche. An initial article by John has been included to show one of the aims in more detail.

David Hooper is retiring from the Committee and the Treasurership and we would like to thank him for his valuable contributions to the activities of the group over the years. We would like to welcome several new members onto the Committee and look forward to their interests and expertise furthering the aims of the group.

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The History of Physics Group: Reflections and some early reminiscences.

I joined the Institute of Physics in the mid 1960's in Kenya, where I taught physics at a sixth form college in Nairobi. My greatest pleasure in teaching was that it provided me with the opportunity to probe, year after year, a wide range of perplexing concepts such as centripetal acceleration, dimensional analysis and the distinction between B and H in magnetism. I became convinced that the philosophy of science was the key to placing my amateur efforts to understand physics concepts on a more professional footing and I returned to Europe in 1972 to study the philosophy and history of science at Oxford. It did not take me long to discover that it was not so much the philosophy of science which illuminated my understanding of physics but the history of science. When I qualified I began to teach the history of science part-time. I took up physics teaching again in 1980 to supplement my income but also because I felt that the historical study of physics without an input from physics itself might cause my understanding of the subject to deteriorate. I revived my lapsed membership of the Institute of Physics and discovered, when looking through the list of groups that there was no History of Physics Group. Encouraged by an article on the history of physics by Professor Jack Meadows in the *Physics Bulletin* I wrote to Clive Jones in late 1982 suggesting that it might be appropriate for the Institute to have a History group. Clive took it up put me in touch with Jack Meadows, Louis Cohen, the executive secretary of the Institute and Brian Gee who had also been interested for some years in establishing such a group. Various enquiries and contacts were made and Jack Meadows and I finally bit the bullet and organised an exploratory meeting with the help and encouragement of Frank Greenaway at the Royal Institution on 1 February 1984. Our intention was to stimulate interest among members of the Institute in a History Group and also to obtain suggestions concerning objectives and possible activities. The meeting was a considerable success. It was strongly supported by senior physicists, physics teachers, academic historians of science and historians working in science museums. A steering committee was set up consisting of Jack Meadows as chairman, myself as secretary with Maurice Ebison, Brian Gee, David Hooper, Nicholas Kurti, Stuart Leadstone, and Raj Williamson as steering committee members.

It took some time to formulate the objectives of the group. We did not wish to duplicate the activities of professional history of science organisations and we wished to define objectives which physicists might find interesting. We finally decided that we should pursue those areas in the history of physics which physicists were particularly competent to investigate and which they would find interesting. After much discussion the main aims of the Group as follows: To secure the written, oral, and instrumental record of British physics for posterity, to foster a greater awareness concerning the history of physics among physicists, and to explore ways in which history can be used to clarify concepts, to improve the quality of teaching in physics and to make the general communication of physics more attractive. Experience brought in other objectives, including the celebration of anniversaries of famous physicists, and the organisation of opportune meetings with other professional bodies.

The institute of Physics formally approved the Group in July of 1984. The first Annual General meeting of the Group was held in Oxford on 3 July 1986, where the Constitution was formally ratified and the steering committee elected to office. Brian Davies from Institute headquarters agreed to help with the running of the committee and Bernard Spurgin was subsequently co-opted onto the committee. The membership of the Group is now about 350, which is about that of a medium sized group in the Institute.

The past ten or twelve years has combined the pleasures of learning a great deal of history of physics from the group meetings with those of social relations with the members of the committee and with those loyal members of the Group who support most of our meetings such as John Simmons and Reg Joyce. The organisation of meetings has often been exhausting, but the good humour of everyone involved and the support from the Institute, particularly from Clive Jones, has made it very worth while. I particularly remember the wit and fertile imagination of Jack meadows in suggesting topics for meetings and the generous help given to the Group by Nicholas Kurti. I was deeply impressed by the effort invested by Stuart Leadstone and Raj Williamson in their organisation of regional meetings and by the high standards established by David Hooper in the Group's Newsletter. I was very fortunate in the early years in having the assistance of a dedicated and entirely voluntary secretary, Mrs Marion Stowell. I was equally fortunate in the voluntary help I received from Dr Ann Geneva in the organisation of the three-day conference on "The History of Physics for the physicist" held at Oxford in July 1986. Meeting committee members at formal committee meetings and encountering committee members at the normal one-day meetings of the Group has been one of the greatest pleasures for me of belonging to the Group.

Has the Group fulfilled its goals, has it had any impact on the thinking of physicists? Prior to the 1980's one not infrequently detected a rather dismissive attitude among some physicists towards the history of physics. There seems to be less of that attitude to-day. However, I do not pretend that the History of Physics Group can take a large share of the credit for this. In the early eighties various professional scientific bodies in England set up history groups, including the Royal Society of Chemistry, The Royal Meterological Society, The Royal Institution and various other bodies. For some unfathomable reason the *zeitgeist* had altered. History of science had become interesting to scientists. With respect to the more detailed objectives of the Group, I feel that we have provided some support and encouragement to the small but dedicated number of physicists who feel that the history of their subject is interesting and important and who otherwise might have felt isolated. In two publications, one edited by Raj Williamson and the second by myself we have recorded the reminiscences and studies by various senior physicists of their life and work. We have organised several conferences dedicated to history in physics education. Our most ambitious conference, that already mentioned, in July 1986 among other objectives attempted to show how the history of physics can help to clarify concepts and be of use in the education of physicists. We have attempted to spread the meetings as widely as possible around the country, the most recent far flung meeting was a very successful meeting on Maxwell organised by Stuart Leadstone in Scotland on 17 April 1993.

Although I feel that the Group has been useful and successful in many ways, I do not feel that we have got very far with promoting active historical research among physicists, a research which only the physicist can carry out once the subject considered passes beyond its elementary levels. I feel also that we have made very little headway in persuading our colleagues that the history of physics can clarify understanding of present day physics or in encouraging ways to exploit history in physics teaching. However, perhaps the *zeitgeist* is not yet ready for that. One thing at a time.

JOHN ROCHE

HISTORY OF PHYSICS GROUP

Several years ago in this magazine M A B Whitaker described an all too common approach to teaching the history of science. 'It presents the scientist not as a hard worker, using all the insight and experience he possesses to solve his problem, but either as a solver of trivia or as a superman, conjuring up answers from thin air. The student' he added 'will have little desire to join the ranks of the former, and little confidence to attempt to join the ranks of the latter' ('History and quasi-history in physics education' *Phys. Educ.* 1979 **14** 108–12, 239–42).

The five years since that was written have seen great developments in the way that the social dimension of science is presented to students. One has only to think of John Lewis's Science in Society project and of the SISCON material to realise that cultural aspects of science—including its historical development and its role in modern society—are now a visible part of the school curriculum. Of course not all the material published matches the standards of those projects. To take just one example, in this issue of *Physics Education* a book reviewer notes that a 200 page biographical dictionary of physicists omits any reference to Marie Curie, Edmé Mariotte or Nicholas Callan.

In this context the recent formation of an IoP History of Physics Group, under the chairmanship of Professor A J Meadows, could be of great value to the teaching community. The Group's aims include 'to explore ways in which history can be used more effectively in the understanding, teaching and general communication of physics' and 'to provide a forum whereby the different and sometimes fragmented disciplines of physics may interact fruitfully'. Activities planned include

- recording interviews with distinguished senior physicists,
- encouraging historical projects which will shed light on difficulties in contemporary physics,
- exhibitions of apparatus and texts,
- summer schools for learning historical skills.

The Group will also be organising one-day meetings, and the first meeting will be on 'Experimenters and instruments: the interaction between experimental skills and instrumental craftsmanship' on Wednesday 20 February at the IoP headquarters. Details of Group membership and of the meeting can be obtained from the Registrar, The Institute of Physics, 47 Belgrave Square, London SW1X 8QX (tel. 01-235 6111).

HISTORY AS SURGERY

John Roche

Physics research continues to move at a headlong pace, leaving little time for reflection. John Roche argues in this article that, alongside the continuing push into the exciting unknown, there is a great need for reflection on, and consolidation of, past achievements

Bertram Boltwood writing to his friend Ernest Rutherford in 1908 complained that: 'As a matter of fact I am getting a little down in the mouth on the radioactivity matter, for I am afraid that the time is rapidly passing when one can hope to accomplish very much with homeopathic doses. I see that someone has given a lot of money for a Radioactivity Institute at Vienna and I am afraid that the wholesale business will drive the small dealer like me to the wall'.

Big science has, of course, become progressively larger since then and one wonders whether this can go on for ever. One possible alternative to this predicament is implicit in a remark of Fritz Rohrlich in 1965:

'With very few exceptions the classical theory of charged particles has been largely ignored and has been left in an incomplete state since the discovery of quantum mechanics . . . I feel that with the present state of our knowledge we are able to look back at the theory, to put it in its right perspective, and above all to *complete* the unfinished work of the past'.

'Completing the unfinished work of the past' has far wider applications, I believe, than the classical theory of charged particles.

A period of discovery

Since the late 18th century physics has enjoyed an unprecedented epoch of discovery, with whole new fields of research opening up in rapid succession. Even today physics believes itself to be in an age of exploration. As a result little effort has been made to re-work old territory to consolidate gains already made or to reconstruct established subject areas critically, from the very foundations, such as has occurred in pure mathematics. Every physicist worth his salt is still expected to be chiefly engaged in pushing back the frontiers of modern physics, while the home front, in many respects, remains neglected.

An enormous experimental and theoretical effort has been invested during the past 200 years in discovering and developing new processes, concepts, laws and devices.

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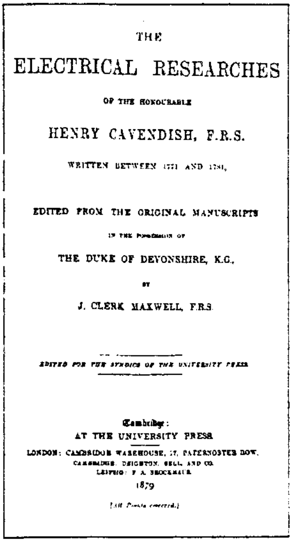
It would be a mistake to imagine that each generation of physicists has purified and clarified all received concepts and laws before handing them on to succeeding generations, or to suppose that everything of value has found its way into print. What I am suggesting is that the vast record of past endeavour in manuscript, in print, in the laboratory and in science museums may have much to offer physics today. This is as true of classical physics as it is of modern physics, but the former, surely, must take priority.

Many topics and subject areas in classical physics which were introduced in the 19th century were left in an unfinished state when physicists re-directed their energies to the new physics, and some still remain incomplete. Hence many of the concepts and laws of received macrophysics are now flawed or obscure, or even incoherent. Since classical physics forms a bridging subject to modern physics it is not at all unlikely that faults in the former may have found their way into the latter. There is now a need for a new period of unhurried consolidation of past achievements in physics, conducted by the best physicists and beginning with classical macrophysics.

Macroscopic physics 'works' very well, of course, but physical theories, like machines and living organisms, can often work effectively even when they are defective. They work much better, of course, when these defects are corrected.



THE
ELECTRICAL RESEARCHES
OF THE HONOURABLE
HENRY CAVENDISH, F.R.S.
WRITTEN BETWEEN 1771 AND 1781,
EDITED FROM THE ORIGINAL MANUSCRIPTS
IN THE POSSESSION OF
THE DUKE OF DEVONSHIRE, K.G.,
BY
J. CLERK MAXWELL, F.R.S.
EDITED FOR THE SYNDICS OF THE UNIVERSITY PRESS
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LEIPZIG: F. A. BROCKHAUS.
1879
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Maxwell, too, was an accomplished historian of physics *(courtesy Cambridge University Press)*

Clarification of concepts

Physics today is top-heavy in mathematical formalism, experimentation and data processing. The qualitative meanings of technical terms, concepts and laws in physics guide and control all mathematical and experimental work, yet they are picked up almost obliquely in the course of study, teaching and research, and the working physicist seems almost afraid to examine them too closely. Nevertheless, it is precisely here that the major hope of future progress in many areas of physics may lie. Nothing should be excluded from this scrutiny, since it is not possible to know in advance where the key to significant progress may be found.

Well known examples of this failure to clarify in classical physics are illustrated by the concepts of force, mass, inertia, kinetic energy, potential energy, angular momentum, tensor, temperature, probability, entropy, self-energy dimensions, electrostatic potential, electromotive force, gauge transformation and above all the concepts of the dual electric and magnetic intensities. Laws and processes which need clarification include the law of action and reaction, surface tension, interference and diffraction, the laws of electromagnetic induction, Kirchhoff's second law, alternating current theory and Maxwell's equations in nonconducting bodies. Even simpler concepts such as centre of gravity, phase, sign convention, units, resultant, and equivalent circuit require elucidation. Furthermore, clear distinctions need to be drawn between experimentally established laws, theories, hypotheses, postulates, models, idealisations, approximations, conventions, fictions and mathematical constructions, since many of these tend to be blurred together in modern physics.

Physics usually invents or discovers its working concepts, laws and distinctions as it goes along, but successful praxis is often far ahead of critical understanding. It is not that there are any missing data, since all of the ingredients required to resolve difficulties in well-established subjects are apparently to hand. Nevertheless, a satisfactory account of certain technical concepts and laws has never been clearly articulated. Physics, however, is totally embedded in such concepts and their clarification can give a confidence, an innovative power, an attractiveness and a fresh impetus to the subject that is, perhaps, lacking in certain areas at present.

It is not possible to carry through such a programme by studying contemporary physics literature and analysing the concepts of physics from that starting point alone. Every technical concept and law in physics has evolved in a very complex manner over the centuries, bearing remnants of the vicissitudes of its past. The flaws being sought are often already deeply embedded in the very concepts being used to analyse them. This makes a purely contemplative analysis of modern physics literature quite self-defeating.

The best hope of tracking down and correcting errors, flaws and obscurities in modern macrophysics is to join a detailed analysis of the foundational literature of a given subject to a thorough understanding of the modern theory. The contrast with earlier conceptions and interpretations both makes us aware of our own presuppositions and helps us to identify and locate the source of defects in the modern theory. It may even suggest ways of clearing them up.

History can also make us aware of, and allow us to detach ourselves from, the various fragments of past and present philosophical systems which abound in modern physics, and which sometimes impose constraints upon the search for satisfactory explanations. History, therefore, can exercise a clinical role in modern physics.

Past and present

Physics needs to integrate a thorough knowledge of its past with its present, as in mathematics. Today, physics is largely conscious of its present only and regards the past as irrelevant or anecdotal. This is surprising in view of the fact that physics is clearly a product of its history. It also contrasts with the manner in which modern physical theory gives time as much importance as space, and even attempts to weld space and time together.

What is being proposed here is a kind of auxiliary or second-order physics – nothing very dramatic, rather an accumulation of clarifications and corrections. Such an approach is suitable only for well-established subjects where there has been sufficient time for the theory to stabilise, and also to test, sift through and digest the concepts and theories generated in such abundance during the foundational period. It is hardly suitable yet for quantum physics, which is just emerging from its charismatic period, or for general relativity and elementary particle physics, which are still in the developmental phase. Something of the sort has already been going on in physics this century, but not in a systematic manner.

From this perspective, scientific archives, oral history and historical apparatus are not just monuments to the past and a quarry for pure historical research. They are a priceless resource for the fine-tuning of modern physical theories and concepts. The breadth of vision, intensity of effort and intelligent insight invested by the founding fathers of any subject is rarely matched in that subject subsequently, and their work is not often fully exploited. Rightly understood, their writings and experimental apparatus will always be nourishing to physics.

Britain can be justly proud of her achievements in physics and of the efforts of dedicated historians and archivists to preserve and make available the scientific remains of the past. Perhaps the time has now come to contribute to this effort and to return to the sources ■

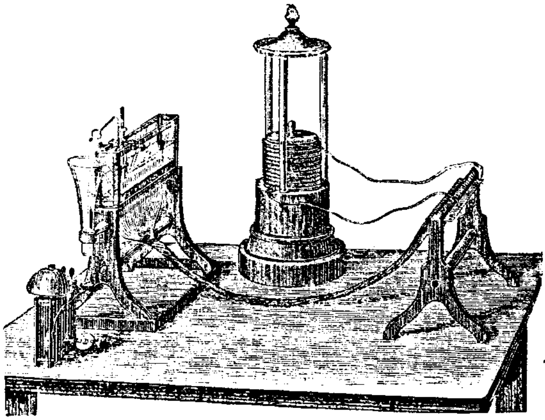

Fig. 2.—Sömmerring's Telegraph.

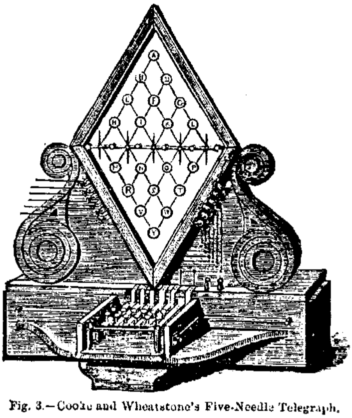

Fig. 3.—Cooke and Wheatstone's Five-Needle Telegraph.

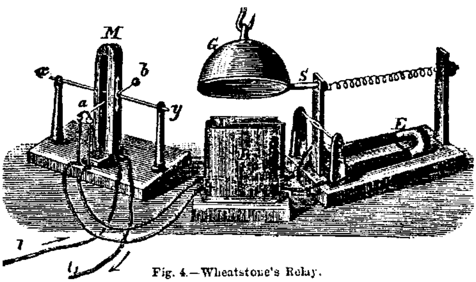

Fig. 4.—Wheatstone's Relay.

William Gilbert and the Elizabethan World

University of Essex July 9 to 11 1993

William Gilbert is justly famous as the author of *De Magnete*, published in 1600, the first sustained application of experimental method in Physics. However, as noted in an earlier Newsletter article (No 6, Autumn 1992), very little is known about Gilbert beyond what can be gleaned from the book. The main reasons are simple. Many Colchester records, including any there might have been concerning Gilbert, were destroyed in the Siege of Colchester during the Civil War. Gilbert's mineral collection and any other holdings of the Royal College of Physicians were destroyed in the Great Fire of London. The almost total lack of primary records means that Gilbert has always been a difficult subject for the historian.

As a physicist based in Colchester with magnetism as one of my main research interests it was natural that I should wish to rekindle interest in one of the Borough's greatest sons. I was lucky in being able to involve Ludmilla Jordanova, a distinguished historian who at the time was based at Essex. We arranged for the Annual Meeting of the British Society for the History of Science to be held, jointly with the History of Physics Group, to explore the context and background of Gilbert's work. We hoped to attract, and indeed succeeded in attracting, three main groups of people: practising physicists, historians of science and local historians. A distinguished and international panel of speakers ranged widely over the religious and social background, the context in philosophy and navigation and the place of Gilbert's work in the history of physics.

Practising physicists were represented by David Tilley, giving a view of Gilbert's study of static electricity and its implication for later work, Rod Wilson (Liverpool), who gave both a physicist's and a geophysicist's view of *De Magnete*, and by Kurt Haselwimmer (Cambridge). The latter discussed his own experimental work on Ditchev's rings, a recently discovered pattern in the behaviour of iron filings on water which can be understood, with some ingenuity, in terms of the interaction of magnetic forces and surface tension. This was the best possible illustration of the continuing vitality of Gilbert's ideas. As an aside, this meeting was unusual in bringing together physicists and historians, and it was fascinating to observe some of the cultural differences between representatives of the two disciplines. The physicists like to give demonstrations and failing that to use diagrams or (in Kurt's case) videos, whereas the historians are more at ease purely with words.

The two pivotal talks of the meeting were perhaps those by Julian Martin (Alberta) on Bacon, Gilbert and the Status of New Natural Knowledge and Piyo Rattansi (King's London) on *De Magnete* and the Cosmology of Love. Martin took as his starting point Bacon's criticisms of Gilbert to whom Bacon gives frequent mention. Bacon criticises first the method of *De Magnete* and particularly the excessive claims for Magnetic Philosophy and second the tone of the work. This latter point is familiar to any modern reader since the style of Gilbert's frequent criticisms of other writers is (in Martin's phrase) quite bilious. Bacon's career, involving early work for the security service as a trusted interrogator, led him to favour state control of invention and to a dislike of 'hot Protestants'. Gilbert's work as the product (ostensibly) of a single author which is so conspicuously lacking in gentlemanly and courtly graces inevitably jarred with Bacon. In the 1580s and 90s texts on mathematics, navigation and practical arts were produced, mainly by hot Protestants. It is clear that Gilbert's associates in his experimental work were artisans, navigators and mathematicians. Furthermore, Gilbert's printer, Peter Short, mainly produced pamphlets by hot Protestants and in fact *De Magnete* was his only work in Latin. The grounds for Bacon's suspicions are clear. The significance of the hot Protestants was clear to all at the meeting after an excellent talk by Patrick Collinson (Cambridge) on Religion in Elizabethan Essex. The perspective Martin gave us on Gilbert is a stimulating one. On one hand, the story of Gilbert's career is of an apparently effortless rise as a physician through aristocratic and courtly circles culminating in his appointment as a physician to the Queen. Yet in his parallel career as a natural philosopher he kept suspect company. Another perspective on Gilbert's political and social position came from Lesley Cormack (Alberta), speaking on Geography and the Creation of an Imperial Ideology in Early Modern England. She brought out the efforts, centering on Geography and Navigation, to create a distinctive Protestant ideology that could be proved superior to that of the Catholic Church. Gilbert's place within this enterprise is clear.

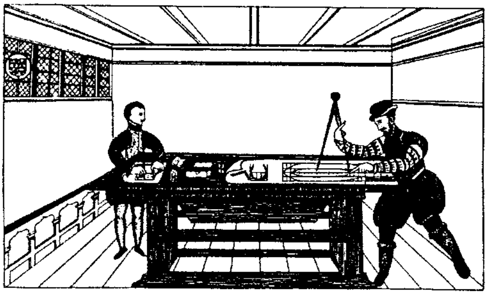

FIGURE 302—*Drawing-office with Tudor ship-wrights at work designing a new ship. The man on the right is measuring with a large pair of compasses preparatory to drawing the long curves which give the shape of the ship's hull. From Matthew Baker's manuscript,* c 1586.

Rattansi shed a very clear light on the connection between Gilbert's experimental work on magnetism and his claims that magnetic philosophy is the key to cosmology. This connection is a point of difficulty for a modern physicist reading *De Magnete* who is likely to respond enthusiastically to the experimental part but reject the cosmology. Rattansi pointed out that for Gilbert magnetic interaction, which he termed coition, is a force of attraction similar to sexual attraction. By extrapolating magnetic interaction to be the force binding the cosmos Gilbert was able to construct a picture in which the planets moved under their mutual attraction and in particular was able to remove the need for the *primum mobile*, the outer sphere moving inner spheres, of earlier cosmologies.

As part of the meeting we organised a Public Lecture by Steve Pumfrey (Lancaster) entitled The Unknown William Gilbert and held in the Moot Hall (main room of the Town Hall). This excellent lecture attracted an audience of well over one hundred. Steve concentrated on the relationship between Gilbert and Edward Wright. Wright was one of the leading mathematical practitioners and contributed an Address at the beginning of *De Magnete* extolling its importance for Navigation. Steve argued, for the first time publicly, that some of the more mathematical sections of *De Magnete* were in fact contributed by Wright. This is a convincing thesis, given that the general mathematical level of the work is not high. As with other contributions, it raises more questions, in particular why Wright's name should have been withheld if he was a part writer.

For the organisers this meeting was a great success in that it drew together a group of people whose interests converge on Elizabethan science, technology and society. As we expected and indeed hoped we are left with more questions to answer.

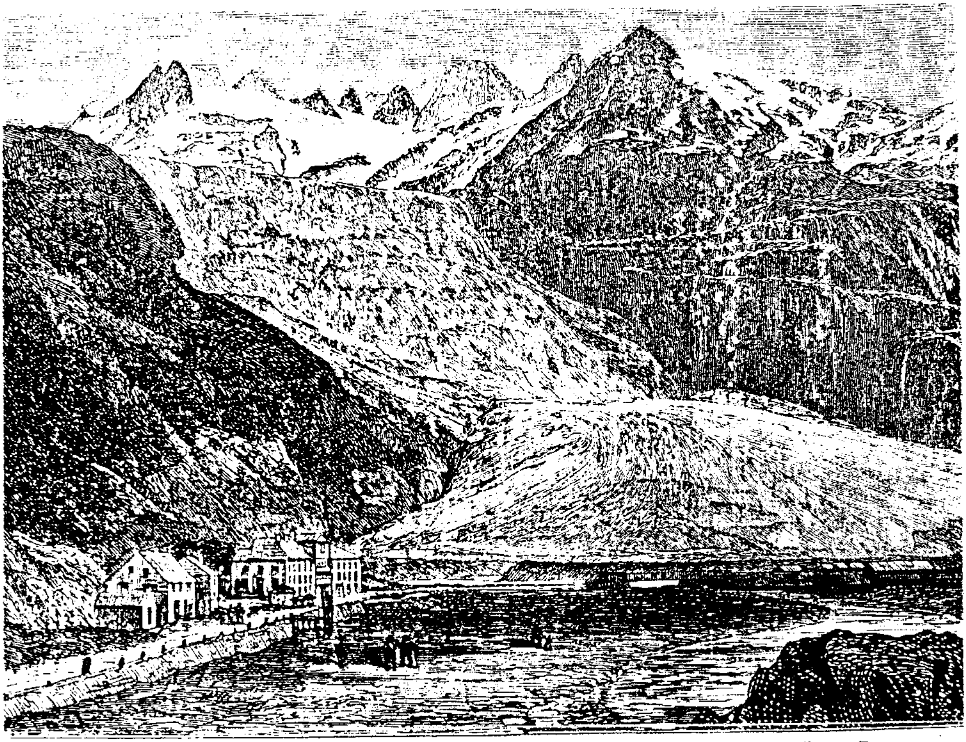

Fig. 15.—The lower Extremity of the Glacier of the Rhône, descending by the Side of the Furca Pass into the Head of the Valley of the Vallais, with the River issuing from it.

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2 Ronald Clark The Victorian Mountaineers (1975)

3 Edward Whymper Scrambles amongst the Alps (1871)

4 Edward Whymper The Ascent of the Matterhorn (1880)

5 J.H. Poynting & J.J. Thomson A Textbook of Physics - Properties of Matter (1903)

BECAUSE IT'S THERE - AND I'M CURIOUS

The Reason

"To my knapsack is strapped a stout piece of rope about thirty feet long, with a Scotch plaid and umbrella ... A couple of thermometers, a pocket klinometer, and a Kater's compass with prismatic eyepiece, may be carried in suitable pockets, along with a note-book and sketch-book, having a fold for writing paper, etc., a good opera-glass, which I find more readily available than a telescope; strong knife, measuring tape, a veil, and spectacles, leather cup, spare cord, and matches. A flask with strong cold tea, to be diluted with water or snow, a tin box for plants, a geological hammer of a form available for occasional use as an ice-axe ..."[2]

So wrote John Ball, who published the first volume of his Alpine Guide in 1863. The list epitomises a spirit of scientific enquiry common to many involved in the golden age of alpine mountaineering in the last century, and links the work of the early great mountain traveller, de Saussure, with the refined mountain-top telescopes and remote sensing of today. Whilst Tyndall's is the most prominent name to feature in the histories of both science and mountaineering, it is not the only one, and it was the expeditions of the early scientists that provided the spur to the growth of true mountaineering. Perhaps the research gave an air of respectability to an activity often regarded as somewhat eccentric, but there is no doubt that most of the men who sought the glaciers and the altitude for studies soon gained a love of the mountain environment in its own right.

Legends of dragons in the high mountains, understandable in the Middle Ages, had not entirely died out by the beginning of the 18th century, indeed in 1708 J.J.Scheuzer (an F.R.S. no less) gave a classification of dragons with scientific care. If the idea of dragons was fanciful, there were also warnings that the air high up would be too thin to support life. Undeterred, a few courageous individuals did venture upwards for their own reasons. The first recorded ascent of a snow peak took place in the 14th century, and Leonardo da Vinci climbed an outlying summit of Monte Rosa.

It was in the relatively benign mountains of the Puy de Dôme that Blaise Pascal, as early as 1648, confirmed that the reduced weight of air above a barometer at altitude would support a shorter column of mercury. Because of his own ill-health, Pascal entrusted the strenuous part of the experiment to his brother-in-law.

In 1770, the Deluc brothers of Geneva climbed the snow-covered Buet. Keen amateur scientists, they took observations of atmospheric pressure and of the boiling point of water. Jean André in particular was to leave his mark on science. He recognised the significance of latent heat (although by then Black had developed his theory) and may have been the first to propose that water vapour in a vessel behaves independently of the air. One of his theories was challenged by the learned de Saussure, then Professor of Physics and Philosophy at the University of Geneva,

"Monsieur Deluc supposes that pure air is heavier than air mixed with water vapour ... "

suggesting that Deluc had not been sufficiently thorough with his experiments. The latter was, of course, to be proved right.

Science, though, had progressed from dragon genealogy to serious observation and the barometer and thermometer, especially, were to be standard equipment for many who walked extensively amongst the mountains in succeeding years.

The Alps, Playground and Laboratory

The herald of the mountaineering scientists - though never a true mountaineer himself - was Horace-Benedict de Saussure. A wealthy man and brilliant scholar, he had been captivated by the mountains as a young man, and spent a large part of his life exploring deep into the Alps, enthusiastically observing, experimenting and recording what he saw. In 1767, on a tour of Mont Blanc, he carried out experiments on the temperature and density of air, on magnetism and on electricity. Some of the instruments he carried on his travels he developed himself, including a hair hygrometer, a magnetometer, an anemometer and what may have been the first electrometer. Another was a cyanometer to measure the blueness of the sky, the very effect later identified with selective scattering by Tyndall, who was to end the era de Saussure had begun.

At the age of 20 the Swiss had his first close view of Mont Blanc. The impression it made prompted him to offer a cash prize for the first to stand on its (main) summit. In 1760, this was unclimbed, not so much for its technical difficulty (a disrespectful climber would call it a 'cow mountain') as for its sheer size, unpredictable weather and the fact that few had been moved to make the attempt.

The feat was accomplished in 1786 by Jacques Balmat and Michel Paccard, the local doctor who had treated Balmat for the ravages of snow glare after a previous attempt on the mountain. Paccard stopped periodically on the ascent to collect specimens and, although they reached the highest point in Europe at 6.30 in the evening, spent half an hour on the summit making observations of

Top: Louis Agassiz and a companion in his "Hôtel des Neuchâtelois," a rough rock shelter on the Unteraar Glacier.

temperature and pressure on instruments he carried in his pockets. The temperature was -6° Reaumur (-28°C) and this, with the chill from a strong wind, must have played a part in the mild frostbite he sustained.

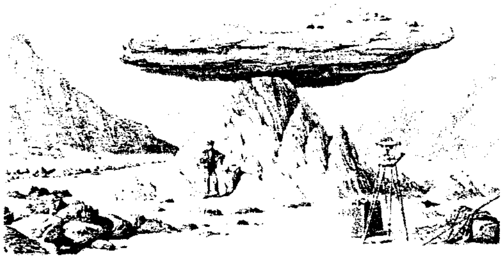
So, man could live and climb at 4 800 m in spite of the rarefied air - about one third down on sea-level density - and no dragons had been observed. Encouraged by the success of Balmat and Paccard, de Saussure himself made what was the third ascent the following year with a large party which included guides employed specifically to carry his scientific equipment. On this occasion, several hours were spent on scientific observations at the summit, the boiling point of water, the temperature of the snow and ... the pulse rate of his guides !

It was not to be long before British scientists were drawn to the unique laboratory of the high mountains. James Forbes was elected to the Chair of Natural Philosophy at Edinburgh in his mid twenties. He had already visited the Alps in his teens on the Grand Tour, as Michael Faraday was to do some years later. (Incidentally, Faraday could certainly lay claim to being a serious mountain walker: On one excursion, and despite illness, he completed a 44 mile walk over the 2300 m Gemmi Pass in ten and a half hours plus a couple of hours' rest.)

Forbes visited the Pyrenees in 1835 to study the geology of the region, and two years later the Dolomites, ostensibly for experiments on terrestrial magnetism. He saw summer visits as complementing his professorial responsibilities, opportunities for serious work, but was soon captivated by the climbing and the scenery.

The great glacier controversy had to be resolved: Glaciers were known to move, but did they do so as rigid bodies, viscous media or by some process of alternate thawing and regelation ? At the invitation of the Swiss geologist Agassiz, Forbes spent three weeks of 1841 at his 'Hôtel des Neuchatelois'. This research facility consisted of a large cave on a rock island in the middle of the Unteraar glacier formed by a large overhanging block of mica schist, with extra weather protection from a wall of stones. Comfort was improved by layers of grass and oilcloth on the rock floor. There, the Scot undertook some scientific work, but also made expeditions into the mountains. With Agassiz and a colleague he made the fourth ascent of the Jungfrau.

On returning to the Alps the following summer, however, Forbes chose Mont Blanc's Mer de Glace for his glacier research. Few guides feature on the scientific side of their employers' ambitions, but Forbes was fortunate enough to have the services of Auguste Balmat, a self-educated man with the enquiring mind of the true scientist. Balmat chipped reference marks on the nearby rocks, and the two were able to measure the movement of stakes they had driven into the ice. Forbes



Above: Forbes's equipment and an impressive glacier table on the Mer de Glace.

established the viscous model of glacial movement and, from his estimate of the rate, predicted that bodies from an earlier accident on the mountain would reappear at the foot of the glacier after 40 years. He was a year out.

It is possible that Forbes could have had a mountaineering career to rival that of Tyndall, but the effects of a serious illness when he was still quite young were to restrict further expeditions. Nevertheless, helped more and more by Balmat, he did continue his fieldwork. In 1851 he travelled to Norway, where he was able to combine glacier work with observation of the solar eclipse.

Another professional, soon to follow Forbes, was Thomas Bonney, for a quarter of a century Professor of Geology at University College London. Bonney realised the potential of the alpine region for his study. Over a period of 35 years - and he was still capable of 'strenuous days in the hills ' at 80 - he made a prodigious number of ascents, being turned back from the difficult Pelvoux by bad weather when there was not even a proper map of the area.

Contemporary with him was John Ball, a man of private means, who also realised how work could be combined with pleasure. Ball's scientific interests, typefied by the contents of his rucksack described above, were mainly in botany and geology. His travels were as impressive as Bonney's, embracing a solo first ascent of the 3 169 m Pelmo, and he became the first president of the Alpine Club.

Left: James David Forbes (1809–68), the Scottish scientist, and his guide Auguste Balmat (1808–62), taking measurements on the Mer de Glace in 1842.

Inspired by a meeting with Forbes to regard the mountains as a source of scientific interest as well as of recreation, was Francis Fox Tuckett. Chief amongst his achievements is the first ascent of the 4 195 m Aletshorn, but his business background may help to explain the thoroughness with which he approached his amateur science:

"He was ... hung from head to foot with 'notions' in the strictest sense of the word, several of them being inventions of his own. Besides such commonplace things as a great axe-head, a huge rope and thermometers, he had two barometers, a sypsieometer, and a wonderful apparatus, pot within pot, for boiling water at great heights, first for scientific and then for culinary purposes."[2]

Note the priorities !

Indisputably the greatest of the scientist-mountaineers was the man whose group was the first to climb the Weisshorn (at 4 505 m the highest distinct mountain still to be climbed in 1861), who climbed Monte Rosa alone on a bottle of tea and a ham sandwich, and who vied with Whymper and the Carrels for the prize of the Matterhorn right up to the moment when Whymper finally claimed it. Yet, John Tyndall is equally known in the world of Physics for his demonstration of the scattering of light which bears his name, and for work on the absorption of heat by gases. Born in Ireland of rather humbler stock than predecessors like de Saussure, Forbes and Ball, Tyndall had to earn his livelihood. After a number of posts in England and in Ireland he left to pursue scientific studies at the University of Marburg (including that of Chemistry under Robert Bunsen). He took a students' walking tour of the Alps in 1849, but it was probably a visit to Switzerland a few years later which kindled his enthusiasm for mountains per se. Following up an interest in the problems posed by the cleavage of slates, he journeyed to the Alps with Professor Huxley. Sensitivity in his writings, distinct from harsh scientific prose, was immediately apparent and it was not long before he was undertaking major climbs for primarily scientific motives. Thus, in 1858 he made observations from the summit of the Finsteraarhorn whilst Ramsay took comparable readings in the Rhone valley three thousand metres below.

Incidentally, whilst A.C. Ramsay's name was made by his work on Snowdonia (he was one of the first to suggest the glacial origin of drift) he too was a lover of mountains,and one of a large party to claim the 4 478 m Lyskamm.

Tyndall, like Forbes before him, engaged Auguste Balmat, valuing his practical expertise in the research, and persuaded the Royal Society to make a grant to the guide in recognition of what he had contributed to the work over and above his skills with an ice-axe.

Before long, the dedication to the cause of science which saw him remain on the summit of Mont Blanc for twenty hours gave way to an equal passion for climbing in its own right. There was still the study of air, sound and light, but in 1860 he reached a high point on the Matterhorn which he would have admitted offered nothing of scientific value which could not have been achieved on easier and higher mountains. He was to lose the race for this one, but had already claimed the Weisshorn; Tyndall and Whymper shared the two conquests they both coveted above all. The first ascent of the Weisshorn was a technical feat well beyond the accomplishments of the earlier scientists.

If the era of the mountaineer motivated initially by scientific investigation ends (in the Alps at least) with John Tyndall, his Matterhorn adversary is well worth a mention. In his glory days, Edward Whymper was driven by the challenge of the difficult ascent, but he was an acute observer and, by contrast, leaned more towards the science in his later years. His name will be for ever associated with the celebrated victory on the Matterhorn, by no means the highest point in the Alps (Ramsay had stood a metre higher on the Lyskamm) but technically of a high order of difficulty. By trade an engraver, he was a man of immense and diverse talents whose classic books illustrate a keen eye for geology, botany and meteorology, not to mention wide reading on a range of scientific and other topics.

TO BE CONTINUED

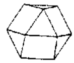
PETER TYSON

LECTURES AND MEETINGS

This information has kindly been supplied by the BSHS and is their copyright. Nearly all these meetings are open to people who are not members of the society concerned, sometimes at a slightly higher cost.We remind readers to check before departure that the event has not been cancelled .

British Society for the History of Science

Learning Science by Reconstructing its History
at Nuffield Curriculum Centre
on 5 March 1994
This meeting will include papers, demonstrations and discussion focusing on the value of replicating historic experiments, both for historians and for educators. Speakers will include O Sibum, P Rolleston and R Staley. Further details from Dr N Russell, Nuffield Curriculum Project Centre, 17 Rathbone Street, London.



• Public Lecture
at University of Leeds, Rupert Beckett Lecture Hall
on 25 March 1994 at 6 pm
This lecture by Professor David Knight is organized jointly with the History of Science Section of the British Association and is part of the National Week of Science, Engineering and Technology (SET7). The lecture is entitled "Words that build worlds". Admission is free. Further details from Frank A J L James, RICHST, Royal Institution, 21 Albemarle Street, London, W1X 4BS.

Making Space: Territorial Themes in the History of Science
at University of Kent at Canterbury
on 28-30 March 1994
This conference will focus on themes to which historians and sociologists have been devoting increasing attention, such as disciplinary boundaries, privileged scientific sites, local, architectural and political spaces and contexts, the spatiality of technology and the historiography of space. Further details from Dr Crosbie Smith, History of Science Unit, Physics Laboratory, University of Kent, Canterbury, Kent, CT2 7NR.

• The Outsider in Science
at Birkbeck College, Malet Street, London
on 14 May 1994
The theme of the meeting, which will be held on the same day as the Society's EGM will consider the life and work of figures who made and published notable contributions to science which were only partly recognised (or not at all) in their lifetimes and who never gained proper professional recognition. Speakers will include F A J L James, I Grattan-Guinness, A A Mills and C Smith. Further details from I Grattan-Guinness, 43 St Leonard's Road, Bengeo, Hertfordshire, SG14 3JW or Roy Porter, Wellcome Institute for the History of Medicine, London, NW1 2BN.

• Science and British Culture in the 1830s
at Trinity College Cambridge
on 6-8 July 1994
This meeting is being held jointly with the Royal Society on the occasion of the bicentenary of the birth of William Whewell. The conference will address the mutual interaction between reform, the sciences and other forms of classical, humanistic and modern knowledge characteristic of Whewell's broad vision. Speakers will include B Hilton, I Morus, G Good, J Hodge, A Winter, J Topham, N Wise, M Rudwick and M Fisch. Further details from Geoffrey Cantor, Department of Philosophy, University of Leeds, Leeds, LS2 9JT. The number of participants is limited. Those who returned the slip circulated with the last Newsletter will receive a booking form. If you are interested in attending but have not yet indicated this to the organizers, please request a booking form from BSHS Executive Secretary, 31 High Street, Stanford in the Vale, faringdon, Oxon, SN7 8LH, UK, as soon as possible.

The Social Context of Science and Technology in Ireland, 1800-1950
at the Royal School Armagh
on 28-29 October 1994
Details of proposed themes and other sponsoring organisations have yet to be finalised. Offers of papers to and details from Peter Bowler, Department of Social Anthropology, The Queen's University, Belfast, BT7 1NN, Northern Ireland.

Writing Scientific Biographies
in London
in May/June 1995
This meeting, to be held in conjunction with the EGM, will continue the series devoted to important biographies, focusing on the Blackwell series of scientific biographies. The aim will be to discuss the value of scientific biographies written for a wider audience, from the perspectives of both the authors and readers of such texts. Offers of papers to Frank A J L James, RICHST, Royal Institution, 21 Albemarle Street, London, W1X 4BS.

Art Historians Association

Forward: Art and Industry (past and future)
at University of Central England
on 8-11 April 1994
One of the sessions of this meeting will be devoted to the history of representation in science and technology. Offers of papers to and further details from Professor Martin Kemp, Department of History of Art, University of St Andrews, St Andrews, Fife, KY16 9AL, Scotland.

British Association, History of Science Section

* Annual Meeting
at Loughborough University
on 5-9 September 1995
The Section is organising sessions on theory and responsibility in science and technology (speakers A R Hall, A Keller, R A Buchanan, N A F Smith, R L Hills), the sociology of science (H Collins, L Wolpert, B Wynne, J Ziman), computers in the history of science (D Gooding, R Tweney, B Stackel and demonstrations) and the history of space exploration (D De Vorkin, J Krige and D G King-Hele). Further details about the programme from Dr Frank A J L James, RICHST, Royal Institution, 21 Albemarle Street, London, W1X 4BS. Details of registration from British Association, Fortress House, 23 Savile Row, London, W1X 1AB.

British Society for the History of Philosophy

Impact of Newton on Eighteenth Century Philosophy
at University of York
on 24-26 March 1994
Further details from R S Woodhouse, Department of Philosophy University of York, Heslington, York, YO1 5DD.

Centre for Philosophy & History of Science

* 1st International Conference on Philosophy of Chemistry
at London School of Economics
on 26-27 March 1994
Speakers include Eric Lewis (McGill), John Green (Univ College, London), Jaap van Brakel (Utrecht), Nikolaos Psarros (Marburg), Paul Needham (Stockholm) and Klaus Rudenehrg (Coburg). Further details from Dr Eric Scerri, London School of Economics, Portugal Street, London, WC2A 2AE. Tel: 081 994 8742.

Cheiron

26th Annual Meeting
at University of Quebec
on 2-4 June 1994
Further details from Andrew S Winston, Cheiron Program Chair, Department of Psychology, University of Guelph, Guelph, Ontario, N1G 2W1, Canada.

Ecole Polytechnique

Colloque Historique International
at Ecole Polytechnique
on 8-11 March 1994
This is being held to mark the bicentenary of the founding of the Ecole Polytechnique Further details from Irina Gouzevitch, Centre de recherche en histoire des sciences et des techniques, Cite des sciences et de l'industrie, 75930, Paris-Cedex 19, France.

European Physical Society

History Teaching Physics
at Szombathely
on 28-30 August 1994
This meeting is designed to support teachers and educationalists interested in the use of the history of science in the teaching of physics. Offers of papers to, and further details from L Kovacs, Teacher Training College, 9702 Szombathely, PO Box 170, Hungary.

International Summer School in History of Science

• Science and Technology after the Second World War
at Cite des Sciences et de l'Industrie, Paris
on 4-15 July 1994
The two sessions will be on "Physical sciences in the old world" led by L R Graham and J Krige and "Reaction and adaptation to the dominant models" led by H Vessuri, I Lowy and J-P Gaudilliere. Further details from D Pestre, CRHST, Cite des Sciences et de l'Industrie, 75930 Paris Cedex 19, France.

International Union of the History and Philosophy of Science

• XIII Scientific Instrument Symposium
at Museum Boerhaave
on 11-16 September 1994.
This meeting will focus on the question "What more can research on scientific instruments offer us than a mere increase of our knowledge of these instruments". Further details from A C Van Helden, Museum Boerhaave, PB 11280, 2301 EG Leiden, The Netherlands.

Le Comite Lavoisier de l'Academie des Sciences

Bicentenaire de Lavoisier
in Paris
on 3-6 May 1994
To mark the bicentenary of the execution of Lavoisier on 8 May 1794, the Comite is planning a number of events. Speakers at the conference will include M Fetizon, R Hahn, K Mengel, J Perrot, R Amiable, M P Crosland, R Robinet and H Kagan. Further details from Michele Goupil, Secretaire du Comite Bicentenaire Lavoisier, Academie des Sciences, 23 Quai Conti, 75006 Paris, France.

Museum Boerhaave

Origins and evolution of collecting scientific instruments
at Museum Boerhaave
on 7-9 September 1994
This conference will examine such issues as the the changing pattern of collecting scientific instruments, why are they of interest to collectors etc. Offers of papers to and further details from Peter de Clercq, Museum Boerhaave, PB 11280, 2301 EG Leiden, The Netherlands.

Newcomen Society

• The History of Thermionic Devices
at Science Museum Annex
on 23 April 1994
Speakers at this meeting, held jointly with the Institution of Electrical Engineers, will be M C Duffy, K R Thrower, T Going, P Leggatt, J R Pierce, M Foley and E Davis. Further details from the Executive Secretary, The Newcomen Society, The Science Museum, London, SW7 2DD.

History of Science Society

• Annual Meeting
at New Orleans
on 13-16 October 1994
Offers of papers etc. which must now be submitted on the HSS Annual Meeting Proposal form (circulated with the HSS Newsletter), should be sent, by 1 April 1994, to Amy Lanfear, HSS Executive Office, DR-05, University of Washington, Seattle, WA 98195, USA.

• Annual Meeting
at Minneapolis
on 26-29 October 1995
Further details from Amy Lanfear, History of Science Society Executive Office, DR-05, University of Washington, Seattle, WA 98195, USA.

ICOHTEC

Annual Meeting
at Bath
on 30 July - 4 August 1994
Particular attention will be given to international aspects of the institutional organisation of engineers, to the manufacture and marketing of gunpowder and to the value of physical artefacts in international comparisons in the history of technology. Further details from Prof R A Buchanan, Centre for History of Technology, University of Bath, Claverton Down, Bath, Avon, BA2 7AY.

Royal Institution Centre for the History of Science and Technology

• RICHST Research Seminar
at The Royal Institution
on 28 February and 21 March at 4.30
These will be Jennifer Tann (Space, Time and Innovation Characteristics: The Contribution of Diffusion Theory to the History of Technology) and Katharine Anderson ('The Lurking Germ of Prophecy': Astro-meteorology and Weather Forecasting in the Nineteenth Century). Further details from Dr Frank A J L James, RICHST, The Royal Institution, 21 Albemarle Street, London, W1X 4BS.

Science and its Publics in Britain, 1851-1914
at the Royal Institution
on 21-23 September 1994
With the recent expansion of concern about the Public Understanding of Science, it seems an opportune moment to re-examine how science was previously conveyed to the public. Is there anything we can learn from past practice? Are we simply continuing a process from the nineteenth century? The main purposes of the conference will be to examine science as culture and also the uses to which science was put by various parts of British society. Particular issues to be addressed will include: the role of the Royal Institution and the British Association in popularising science; the work of Tyndall and Huxley in this area as well as their's and other's views on the relation between science and religion; the role of science in the political, legal, educational and technological worlds; the display of science at exhibitions (such as 1851), conversaziones and museums; science as popular culture expressed through the Lit & Phils, scientific clubs, newspapers, science fiction and the evening class movement. Further details from Dr Frank A J L James, RICHST, The Royal Institution, 21 Albemarle Street, London, W1X 4BS.

Royal Meteorological Society History Group

• Colonial Meteorological Observatories and Networks
at Durham University
on 8-10 April 1994
This two day meeting is being planned with other interested groups. Further details from R Lewis, c/o Royal Meteorological Society, 104 Oxford Road, Reading, RG1 7LJ.

Society for the Social History of Medicine

The Body and Beyond
at Birkbeck College
on 16 April 1994
Speakers will include H King, R Evans, T van der Meer, A McLaren, F Dikotter and S Squier. Further details from Dorothy Porter, Department of History, Birkbeck College, Malet Street, London, WC1E 7HX.

Societat Catalana d'Historia de la Ciencia i de le Tecnica

• Bicentenari de Lavoisier
in Barcelona
on 25-26 May 1994
This meeting will commemorate the second centennial of Lavoisier's death. Speakers will include M P Crosland, B Bensaude-Vincent, R Gago, M Izquierdo, A Estany and A Nieto. Further details from the Conference Secretariat, Societat Catalana d'Historia de la Ciencia i de le Tecnica, C/ Carme, 47, 08001 Barcelona, Spain.

International Leibniz-Kongress

VI Congress
on 18-23 July 1994
Leibniz and Europe will be the central theme of this congress. Further details from Gottfried-Wilhelm-Leibniz-Gesellschaft eV, Niedersachsische Landesbibliothek, Waterloostr 8, D-30169 Hannover, Germany.

• Sir William Ramsay and the Noble Gases
at University College London
on 27 October 1994
This one day meeting will be held jointly with the Dalton Division of the Royal Society of Chemistry. The historical part will comprise papers by K Gavroglu, K Watson, P Morris and E Scerri. Further details from Dr J H S Green, 2 St James's Avenue, Hampton Hill, Middlesex, TW12 1HH.

The Scottish 'Chemical Revolution': Scientific and Industrial Inheritance
at Heriot-Watt University, Edinburgh
on 10-13 April 1995
This historical symposium, partly in collaboration with the Education and Industrial Divisions, will form part of the Annual Congress of the Royal Society of Chemistry. Further details and offers of papers to H R Jones, 54 Chilbolton Avenue, Winchester, Hampshire, SO22 5HQ.

Technische Universitat Chemnitz-Zwickau

Agricola-Ehrung 1994
at Chemnitz
on 25-26 March 1994
This conference will mark the 500th anniversary of the birth of Agricola. Offers of papers to and further information from Technische Universitat Chemnitz-Zwickau, Agricola-Ehrung 1994, Postfach 964, 0-9010 Chemnitz, Germany.

UNESCO

20th Century Science: Beyond the Metropolis
at Paris
on 19-22 September 1994
To mark the 50th anniversary of ORSTOM, this joint meeting with UNESCO is being organised. Historical topics will include discussions of the role of the scientific community since 1944, changing concepts of tropical medicine and the transfer of science and technology. Further details from Mme Laurence Porges, Colloque du Cinquantenaire ORSTOM, 213 rue La Fayette, 75010 Paris, France.

Universitat Duisburg

• Drittes Mercator Symposium
at Duisburg
on 10-11 March 1994
Speakers include Drs Buttner, Bergsma, Holze, Roegiers, Walton and Watelet. Further details from Rene Dirven, Gesamthochschule, Universitat Duisburg, D-47048 Duisburg, Germany.

JEMIMA ON TOUR

We remind readers that the exhibition is still on tour and can be viewed at the locations below.

Barrack Street Museum, Dundee	Feb - April 1994
Mercer Gallery, Harrogate	April - May 1994
Brantwood, Coniston	May - June 1994
Inverness Museum and Art Gallery	July - Aug 1994
The West Highland Museum, Fort William	Aug - Sept 1994

Figure 11.2 North view of the new and old towns of Edinburgh, from Inverleith, 1781. (By courtesy of the Edinburgh City Libraries.)

CLERK MAXWELL'S BIRTHPLACE OFFICIALLY ACQUIRED

The negotiations by the James Clerk Maxwell Foundation to purchase Maxwell's birthplace at 14 India Street, Edinburgh were completed in September 1993. The dwelling will be shared by the Foundation and the International Centre for Mathematical Sciences. The ICMS was founded by Edinburgh and Heriot-Watt Universities and has now been joined by Stirling University.

To mark the acquisition of the birthplace a celebration was held in the house on Friday 26th November 1993, jointly hosted by the Foundation and Canongate Press. The organisers of the touring exhibition of the work of Jemima Blackburn (cousin of Maxwell) had kindly agreed to an additional showing in the house itself, and so guests had the privilege of viewing the 200 or so examples of her work, including some figuring cousin James. In addition Canongate's newly published *Blackburn's Birds* was launched, this being Rob Fairley's second book on the work of Jemima.

Magnus Magnusson presided benignly over the proceedings and he and David Ritchie (both old boys of Edinburgh Academy, as Maxwell was) addressed the gathering in fitting fashion. A further entertaining contribution from Rob Fairley closed the formal part of the proceedings.

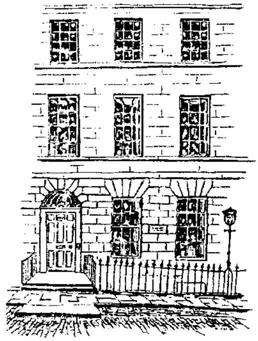
A few copies of the previous Newsletter, containing a full report of the Maxwell Meeting of last April, are still available. New Group Members and others who missed this may obtain a copy by sending me an SAE (A5 size with 29p stamp please). (See "Articles of Historical Interest" for address.)

Stuart Leadstone

MAXWELLIAN THEMES

IN THE

EDINBURGH INTERNATIONAL SCIENCE FESTIVAL 1994



Following the completion of the purchase of the birthplace of James Clerk Maxwell at 14 India Street Edinburgh and its conversion as an international study centre, a symposium will take place there on Saturday 16th April 1994. The speakers will address some of Clerk Maxwell's wide ranging and continuing contributions to science and technology. There will be a second symposium suitable for senior school pupils on Tuesday 19th April

11am - 1pm

Professor Sydney Ross (Rensselaer Institute, USA) - "Maxwell's colour photograph - A riddle resolved and a relic revived".

Professor George Walker (University of Alberta, Canada) - "Maxwell's Electromagnetic Equations - A reappraisal"

2pm - 4pm

Professor James Ferguson (University of Strathclyde) - "Rheology - The deformation and flow of materials

Dr Graeme Watt (Royal Observatory, Edinburgh) - "The James Clerk Maxwell Telescope in Hawaii - Probing the sub-millimetre heavens".

A shortened version of the symposium suitable, for senior school pupils, will be given on the afternoon of Tuesday 19th April in the hall of The Edinburgh Academy, the school attended by Clerk Maxwell.

For further information, apply to Prof D.S.Ritchie, James Clerk Maxwell Foundation, 11 Ann Street, Edinburgh EH4 1PL, Tel 031 332 1455.

THE BIRDS OF MAXWELL'S HOUSE

THE acquisition of the Edinburgh home of the great Victorian physicist and mathematician James Clerk Maxwell by the foundation which bears his name represented the fulfilment of an ambition which goes back to its launch in 1977. Negotiations to buy 14 India Street began in 1989, and were completed in September.

Clerk Maxwell, (1831-1879) another Scot more venerated elsewhere than in his native land, grew up in this elegant terraced house, which will now be used as an international study centre for the mathematical sciences. His most important research lay in the field of electromagnetic radiation, and he is a crucial forerunner of Albert Einstein and Max Planck.

While the focus of activity here will be on scientific work, it is currently hosting an excellent exhibition of Victorian watercolours. As a boy, James would often have been visited by Jemima Wedderburn, who lived in nearby Heriot Row, and demonstrated a precocious talent for drawing and painting.

They were lifelong friends, and Jemima also sealed the union of arts and sciences when she married mathematician Hugh Blackburn in 1849.

Her work as Jemima Blackburn was famous in its day, but has been neglected in our time. This exhibition shows some 200 paintings from a stock of 4,500 currently held in the family home at Rushven, Loch Ailort, where much of her work was done, although others are held (but not always displayed) in national collections.

The upstairs rooms focus on foreign travel and Highland life. If her human figures are occasionally a little stiff and formal, these watercolours reveal a highly perceptive eye, and have a wonderful vibrancy about them. Her fresh use of colour and fine compositional sense enhance the natural appeal of the landscapes, whether on her doorstep in the wilds of Moidart, or in exotic locations abroad.

The Scottish paintings include two small drawings of the youthful Clerk Maxwell. In addition to their intrinsic charm, these watercolours — and this is only a fraction of them — also add up to a wide-ranging picture of Victorian famly life, since she was nothing if not a diligent recorder of the life around her.

Famous Grouse: (top right) is Jemima Blackburn's pair of red grouse; (above) the delicately painted ringed plovers and (right) the crossbills feeding on a branch, all on display at James Clerk Maxwell's house

The principal glory of the exhibition, however, lies in the downstairs room. Her *Birds & Beasts*, and especially the birds, are exquisite examples of the art. Unlike Audobon and Lear, she rarely worked from stuffed specimens, preferring to rely on observation and memory to fix the subject in her mind.

The results are invested with a startling naturalness even now, and avoid the clinical artificiality of much bird painting. They seem almost to breathe, and demand to be considered not as representatives of a species, but as individualised portraits. There is nothing impressionistic in the actual rendering, however, which reveals the birds in precise and gloriously crafted ornithological detail. Hurry along for this exhibition continues only until 22 December.

Many of the paintings are also included in *Blackburn's Birds* (Canongate, £25), Rob Fairley's second book about the painter.

Blackburn published her paintings in *Birds from Nature* (the definitive version appeared in 1868) and *Birds from Moidar* (1895), and Fairley has drawn on her accompanying text in both these books, as well as on some previously unpublished manuscript sources.

The range of subjects is impressive even in this selection, from commonplace birds like the hedge sparrow, elegantly framed in a tangle of thorns, or the starling rooting under stones for worms, to the larger and rarer species, as in a magisterial long-eared owl or a selection of birds of prey which includes a vividly powerful sparrowhawk making a kill. Her seabirds are equally impressive, notably her studies of guillemots, and a particularly graceful painting of a common tern, accompanied by a beautiful miniature of a tern chick. Her scientifically important studies of the behaviour of fledgling cuckoos is also recorded in some detail.

Kenny Mathieson

© Kenny Mathieson 'The Scotsman' Newspaper, Friday, 17. 12. 93

Dear Editor

Many symbols used in Physics have an obvious origin e.g. m = mass, p = pressure. Others may be abbreviated from a foreign word if the original theory was developed elsewhere. Many, one suspects, were simply among the only English letters left and selected more or less arbitrarily. Do any of the members know of the reason for common ones like:

f	when used for	acceleration
s		displacement
I		current
E		Youngs Modulus (sometimes Y)
c		speed of a wave
h		Planck's constant
q		charge
V		potential
R		general gas constant (molar)

and furthermore

L	inductance
B	flux density
U	internal energy
S	entropy

Do members know of the earliest use, by whom, and why, if not arbitrary? Do any of the Greek letters we use come from Greek words? e.g.

λ	wavelength
ν	frequency
μ	refractive index; mobility; coefficient of friction

I would be grateful if any readers can give me some information on these matters.

Walter Cairns

Dear Editor

I would like to inform members that Prof. Harry Rosenberg died of a heart attack in Brazil a few months ago. Shortly before his death he was organising a meeting to inform members of developments with the Rayleigh artefacts in Essex. He will be sadly missed by colleagues and members alike.

John Roche

To the Editor of the 'History of Physics Group' Newsletter

Concerning 'Mr. Phactphinder's Paraphernalia'

When I joined the Physics Department at Kingswood School , Bath in 1953 under C.W.Kearsey, who was himself a highly ingenious designer of experiments, I found that the equipment available included some items of teaching apparatus stretching back over many years, including that shown on the lower half of page 30 in your Summer 1993 issue. Kingswood had a long record of including science in its curriculum. There is a record of money spent in 1808 on repairs to an electrical machine and an air pump and in 1814 a telescope was purchased for eleven guineas. Later in the century there is a note that one of Mr. Griffiths' science lectures was cancelled for a confirmation class! Fletcher, whose trolley I used well before the modern Nuffield version was designed, had been a pupil at the school.

The apparatus you illustrated was used in the study of sound. The key item is the small sphere attached to the top of the stand. It is made as two hemispheres screwed together with a circular diaphragm in the diameter plane dividing the interior space. One half has a gas supply (note the tap) and the narrow angled pipe provides a small manometric flame. The other half is connected by rubber tube to a mouthpiece into which sounds are made which, via the diaphragm, cause pressure variations in the gas pressure to the flame. The resulting variations in flame height are observed by reflection in the four vertical mirror sides of the rotating cube - providing ,incidentally, an excellent illustration of the principle of the oscilloscope in terms more easily comprehended than the electronics inside a box.

I used a gramophone turntable to rotate the mirrors at a steady rate, though now that I seen your illustration, I suspect that the mechanical system shown may have been an item in another cupboard among a miscellany that I sometimes used to get pupils discussing cogwheel linkings and velocity ratios. I never attempted more than an estimate of number of waves in the mirror width. The reasonably continuous narrow trace when the flame was steady was broadened into a series of somewhat jagged spikes, perhaps a couple of cm high, when mouth sounds were made into the mouthpiece. Even in the reproduction the diagram shows this effect. Frequency changes and the presence of harmonics could be demonstrated. Apparatus from the Brass Age should not be treated with condescension! Except when syllabus pressure forced a reduction in time available for studying sound I liked to demonstrate with this apparatus before pupils went on to do the same thing with an oscilloscope and I had certainly not relegated it to the museum cupboard when I retired in 1985.

John Ede
Head of Physics
Kingswood School, Bath
1961 - 1985

Koenig's Manometric Flames.—Manometric flames, or flames showing variations of pressure, are especially suitable for comparing the relative frequencies of pipes. A manometric flame is

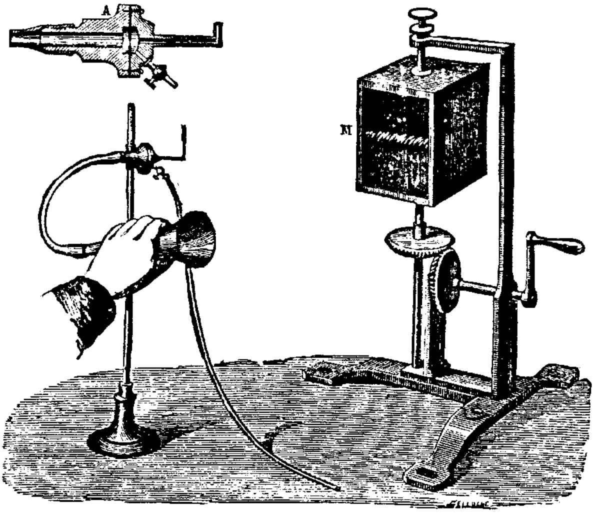


FIG. 22.—Koenig's Manometric Flame.

arranged as shown in Fig. 22, A. The gas, on its way to a pinhole burner, passes through a small chamber closed on one side by a membrane three or four centimetres across. If there are rapid variations of pressure on the left-hand side of the membrane, it moves in and out, and checks or aids the flow of gas to the burner. The flame is thus made variable, and jumps up and down with a frequency the same as that of the membrane. If, for instance, a note be sung into a mouthpiece connected with the left-hand compartment, the flame is affected. But in general the vibrations are too rapid to be seen separately, and the only direct indication of their existence consists in the peculiar drawn-out appearance of the flame, as shown in Fig. 23, where *a* shows its shape with steady pressure and *b* its shape when jumping up and down. If the eye be rapidly carried past the flame,

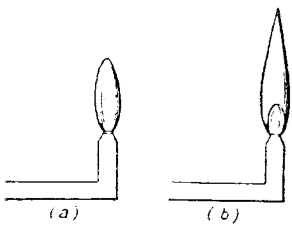


FIG. 23.—Manometric Flame. (*a*) pressure steady; (*b*) pressure intermittent.

its intermittent nature is at once revealed by a jagged or toothed appearance. To show this properly, a cubical box (Fig. 22, M) with a plane mirror on each of its four vertical sides is rotated rapidly about its vertical axis, and the reflection is viewed in the mirrors. A band of light is then seen, continuous when the flame is continuous, jagged or toothed (as in Fig. 24) when it is intermittent. This figure, given by Koenig, shows the effect of sounding vowels into the mouthpiece pitched on different notes. For comparing the frequencies of two pipes or other sources, two manometric flames may be placed close together, affected respectively by the two sources, and their reflection compared, the number of teeth in the same distance on each being counted.

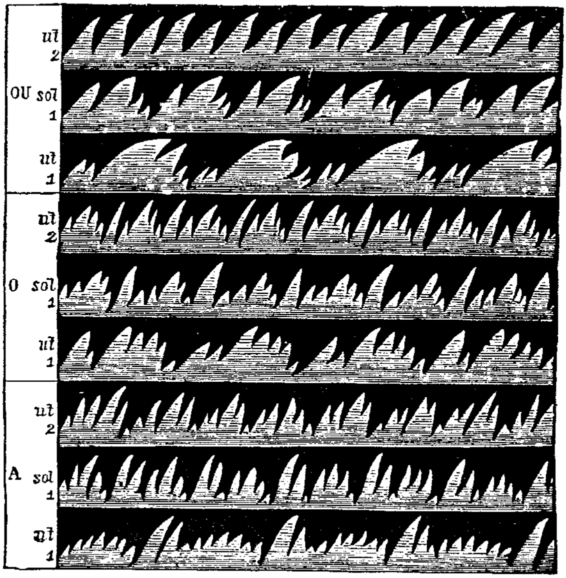


FIG. 24.—Flame-Pictures of the Vowels OU, O, and A (*Koenig*).

Lissajous' Method of Comparing Forks.—This method consists in studying the curves formed by the composition of the two vibrations to be compared when they are arranged at right angles. We only mention it here as a possible method, but we shall describe it later (p. 77) when we have discussed the subject of the composition of vibrations.

In concluding the subject of determination of pitch, it may be worth while to mention a method of determining very roughly the frequency of a source when that of another, say a fork, is known. This consists in tuning a monochord or sonometer (p. 81), so that

Koenig's Manometric Flames from Poynting and Thomson 'Textbook of Physics: Sound (2nd Edition London 1900)

207. **Deportment of Water in Freezing.**—When water freezes, it undergoes a sudden expansion. The amount of its expansion is found to be about 10 per cent.; more exactly, 1000 cubic feet of water at the freezing point become 1102 cubic feet of ice at the same temperature.

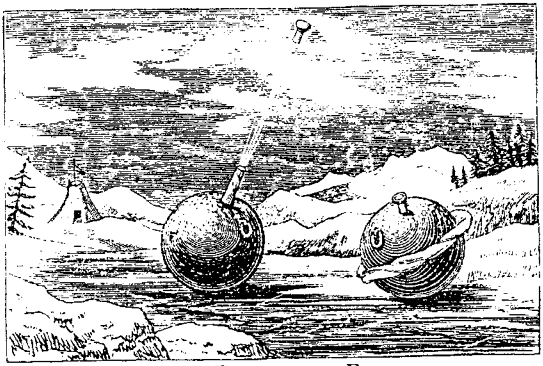


Fig. 173.—EXPANSION IN FREEZING.

The force of this expansion is almost irresistible. A strong iron bottle filled with water, and firmly closed, when immersed in a freezing mixture, is rent asunder in a short time. Some interesting experiments on this point were made one severe winter at Quebec by Major Williams. He took a bomb-shell, and having filled it with water, carefully plugged up the aperture; on exposing it to the frost, the plug was driven to a distance of 330 feet, whilst at the same time a cylinder of ice 8½ inches long appeared protruding at the aperture (fig. 173). In another experiment, the plug being more firmly fixed, the bomb was ruptured at the middle, and a ring of ice was forced through the rent.

The illustrations of the Manometric Apparatus, theExpansion in Freezing and Light proceeding in straight lines were all taken from 'Acoustics, Light, and Heat' by W. Lees, M.A.,published by Collins, London and Glasgow, 1880

The Open University

PHYSICS

OPEN UNIVERSITY BROADCASTS ON THE BBC 1994

TELEVISION

THE PHYSICS OF MATTER - S272

BBC2 06.50 Saturdays

19/2	How Low Can You Go? (Part 1) (06.25)
12/3	A Macroscopic Approach
09/4	The Maxwell-Boltzmann Distribution (08.55)
07/5	Ideal Sounds
21/5	How Low Can You Go? (Part 2)
18/6	Probing the Structure of Solids
02/7	Elastomers
22/7	Phonons (Fri 06.20)
19/8	Light from Semi-conductors(Fri 06.20)
16/9	Probing the Structure of Liquids (Fri 06.20)
24/9	Superflow (07.15)

DISCOVERING PHYSICS - S271

BBC2 24.00 Tuesdays repeated
24.00 Tuesdays 1 week later

22/2	Newton's Revolution
14/4	The Physics of Ball Games
07/7	Magnetic Fields in Space
29/9	Seeing with Electrons

OCEANOGRAPHY - S330

BBC2 07.55 Sundays

06/2	What is Oceanography? (50 mins)
24/2	Ocean Floor (Thurs 07.35)
25/3	Jamaica and the Sea (Fri 06.20)
08/5	Currents
15/5	Oceans and Climate
09/6	Sea-level (Thurs 24.00)
31/7	Rockall
28/8	Waves
25/9	Polar Oceans

ASTRONOMY AND PLANETARY SCIENCE - S281

BBC2 08.45 Sundays repeated
24.00 Thursdays same week

20/2	Our Invisible Sun
20/3	Good Seeing
24/4	Cosmic Recycling
22/5	Venus Unveiled
19/6	Design for an Alien World
17/7	Mapping the Milky Way
14/8	Jets and Black Holes
11/9	Cosmology on Trial

BBC2 24.00 Tuesdays

31/5	The Third Dimension (06.45)
14/6	Holography at Work
28/6	Lens Design
12/7	Viewing the Invisible (06.45)
26/7	Beyond the Eye (07.10)
09/8	The Crab Nebula
23/8	The Surface of Mars (07.10)
09/9	Viewing with Electrons (07.10)
20/9	Seeing with Sound
27/9	Imaging the Eye

UNDERSTANDING SPACE AND TIME - S354

BBC2 06.00 Saturdays

12/2	Before Einstein (50 mins)
19/2	Mr Galileo was Correct
05/3	As Surely as Columbus Saw America
19/3	Pushed to the Limit
09/4	A Feel for Space
23/4	A Conflict Brought to Light
07/5	Marking Time
21/5	$E=Mc^2$
04/6	Through the Looking Glass
18/6	An Isolated Fact
02/7	A Matter of Geometry
16/7	At the Frontier
30/8	Curiouser and Curiouser
19/8	Measuring Shadows (the Universe today)
27/9	A Note of Uncertainty (the Universe tomorrow)
10/9	Vanished Brilliance (the Universe yesterday)
24/9	Shades of Black

A SCIENCE FOUNDATION COURSE - S102

BBC2 08.05 Saturdays repeated
07.10 Thursdays same week

05/2	The Planet Earth
12/2	Measuring the Earth and Moon
19/2	Motion - Newton's Law
09/4	Energy
16/4	Light in Search of a Model
17/9	Quantum Physics: Electrons and Protons
24/9	Quantum Leaps into the Atom
01/10	The Search for the W and Z

SCIENCE MATTERS - S280

BBC2 24.00 Wednesdays
All 50 minute Programmes

15/6	Taking Risks
29/6	The Human Genome Project
13/7	Programme 3
27/7	Programme 4

FOOD PRODUCTION SYSTEMS - T274

BBC2	**07.10**	**Tuesdays**
22/2		The Grain Story
22/3		The Green Machine
26/4		Deer Farming
24/5		Novel Proteins
21/6		Today's Beef
19/7		The Kenyan Small Farmer
16/8		The Mumias Sugar Scheme
13/9		The Will tc Win

MODELLING WITH MATHEMATICS - TM282

BBC2	**06.45**	**Tuesdays**
15/2		Modelling and the Modelling Cycle (24.00)
22/3		Seatbelts
26/4		Rates of Change
24/5		Modelling Planetary Motion
21/6		Water by the Volume
19/7		Floating an Integral
16/8		Natural Model
13/9		Modelling in Comfort

ENVIRONMENTAL CONTROL AND PUBLIC HEALTH - T237

BBC2	**11.25**	**Saturdays**
12/3		Environmental Control in the North Sea
14/5		Going with the Flow
11/6		Energy from Waste
25/6		Paper
16/7		The Management of Nuclear Waste (10.10)
06/8		Noise Annoys
27/8		Keeping Watch on the Invisible
17/9		Raising Arms Against Air Pollution

PROJECT MANAGEMENT - SYST 999

BBC2	**07.10**	**Tuesdays**
03/6		Docklands Light Railway - 1(Fri 07.10)
14/6		" " " 2
21/6		" " " 3(07.35)
28/6		Watts in the Wind

ASTRONOMY AND PLANETARY SCIENCE - S281

BBC2	**08.45**	**Sundays repeated**
	24.00	**Thursdays same week**
20/2		Our Invisible Sun
20/3		Good Seeing
24/4		Cosmic Recycling
22/5		Venus Unveiled
19/6		Design for an Alien World
17/7		Mapping the Milky Way
14/8		Jets and Black Holes
11/9		Cosmology on Trial

MATERIALS - T203

BBC2	**24.00**	**Tuesdays repeated**
	07.10	**Tuesdays 1 week later**
22/2		Why Engineering and Science?
29/3		Catalysts Against Polllution
26/4		Hidden Power
10/5		Light Fantatic
24/5		Strike A Light
05/7		Going through a Phase
02/8		Spanning Materials
13/9		Given Enough Rope

WORKING WITH SYSTEMS - T247

BBC2	**06.45**	**Tuesdays**
07/2		Traps - and Ways Out of Them (Mon 24.00)
08/3		Diagrams
12/4		Of Fish and People
10/5		Coping with Queues

MANAGING IN ORGANISATIONS - T244

BBC2	**24.00**	**Mondays**
14/3		Boundaries and Biases
18/4		Managing the Managers
16/5		"Who do you think you are talking to?"
13/6		Trading on Uncertainty
11/7		An Everyday Story of Industrial Folk
05/9		Boundaries and Biases

INSTRUMENTATION - T292

BBC2		**Sundays at various times repeated Fridays same week at different times**
13/2		Made to Measure (07.30)
25/9		Instruments under Wraps (06.15)
02/10		Instruments in Flight (07.05)

DESIGN: PRINCIPLES & PRACTICE - T264

BBC2	**00.25**	**Tuesdays repeated twice**
	00.25	**Tuesdays of the following week**
01/2		People & Mechanisms/Drawing(48 mins)
22/3		Product evaluation (53 mins)
15/3		Bicycles (60 mins)
12/4		Symmetry in Design (39 mins)
10/5		Cars (52 mins)

COMPUTER AIDED DESIGN - T363

BBC2	**00.25**	**Wednesdays repeated twice**
	00.25	**Wednesdays of the following week**
04/02		Introduction (Fri - 27 mins)
23/2		Graphics & draughting (59 mins)
16/3		Modelling (53 mins)
13/4		Analysis (58 mins)
04/5		Reality (57 mins)

A FOUNDATION COURSE: LIVING WITH TECHNOLOGY - T102

BBC2	**08.30**	**Saturdays repeated Tuesdays**
	06.45	**1 or 2 weeks later - All Programmes 50 mins**
05/2		The Climates of Opinion
12/2		The Best Laid Plan; Bridging the gap
12/3		Information Technology at work
16/4		Piping hot/Changing Stations
28/5		Resources: Aluminium, copper and water
02/7		Green machines/nitrate in drinking water
30/7		Patterns in the dust/Driven clean away
27/8		Writing a report

AN INTRODUCTION TO INFORMATION TECHNOLOGY - DT200

BBC2	**07.15**	**Saturdays repeated**
	06.25	**Saturdays 1 week later**
26/2		Information Technology: A Revolution?
12/3		The Telephone: Birth of a Technology
26/3		Light Fantastic
16/4		Teletel
30/4		IT for You
14/5		Banking, Money and Machines
28/5		What's in Store?
11/6		IT in Bank Training
25/6		Learning Through Interactive Video
09/7		India: Space for Education
23/7		Computer Integrated Manufacture
06/8		CIM in the Workplace
20/8		Putting IT in its Place
03/9		INSAT: Implications for a Nation
17/9		The DHSS
01/10		Contrasts

ENGINEERING MECHANICS: SOLIDS - T235

BBC2	**24.00**	**Tuesdays repeated**
	07.35	**Thursdays 10 days later**
08/3		Linkage Mechanisms
12/4		Free Body Diagrams
11/5		Velocity Diagrams (Wed 06.45)
07/6		Dynamic Analysis
19/7		Structural Components
16/8		Work and Energy
30/8		Vibrations
14/9		Lift Design (Wed 06.45)

ENGINEERING MECHANICS - T331

BBC2	**06.45**	**Tuesdays repeated Fridays 1 week later**
14/6		Fluids
02/8		Vibrations

DESIGN AND INNOVATION - T362

BBC2	**07.35**	**Tuesdays repeated**
	06.20	**Fridays same week**
15/2		Eurekarrgh (Part 1)
15/3		Eurekarrgh (Part 2)
19/4		Gallium Arsenide - Pulled from Obscurity
17/5		Marketing the Micro
14/6		Innovation on the Rails
12/7		Power to the People?
09/8		Images and Innovation
06/9		The Golden Rule

GRAPHS, NETWORKS AND DESIGN - TM361

BBC2	**06.00**	**Saturdays**
26/2		What is Combinatorics
12/3		Telecommunications Networks
26/3		Minimum Cost Flows
16/4		Counting Atoms
30/4		Critical Path
14/5		Latin Squares
28/5		The National Grid
11/6		An Offshore Gas System
25/6		Rook Polynomials
09/7		Mechanical Manipulation
23/7		Transportation Algorithms
06/8		Are Four Colours Sufficient?
20/8		Silicate Structures
03/9		The Mariner 9 Code
17/9		The Location Problem
01/10		In Conclusion

SCIENCE, TECHNOLOGY & EVERYDAY LIFE 1870-1950 - A282

BBC2	**07.10**	**Fridays repeated**
	00.25	**Thursdays 6 days later**
04/3		It's a Lovely Day Tomorrow (07.35)
25/3		The All Electric Home
29/4		The March of Aluminium
27/5		Wheels of Progress (06.45)
24/6		Invasion from Mars
22/7		The Cornflake Story
19/8		Soap and Water
15/9		Childbirth and Contraception (00.25)

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ARTICLES OF HISTORICAL INTEREST FROM "PHYSICS EDUCATION"

The periodical *Physics Education* was launched in May 1966, sponsored by The Institute of Physics and The Physical Society, as a "new journal devoted entirely to the teacher of physics". It has been an important and helpful source of dialogue between physics teachers at secondary and tertiary level, more recently extending its domain to include primary science. Over the 28 years of its publication there has been a steady trickle of articles of historical interest - about 5 per year on average. It occurred to me that members of the History of Physics Group might find it useful to have a complete listing of these "historical" contributions. Ideally a short summary should accompany each item, but this was too time-consuming a task to contemplate! As a compromise I have decided to cover the past issues by means of a two-part listing, the years 1966-80 being given in this issue of the Newsletter, and 1981-94 in the next. Thereafter it may prove feasible to provide updates, complete with abstracts. Positive feedback from readers of this Newsletter would strengthen my resolve! In the meantime, if anyone has difficulty in getting hold of any particular article which may interest them, they are welcome to drop me a line to:

Stuart Leadstone, "Hallyards", South Deeside Road, Banchory, Kincardineshire AB31 3HX.

Part I:Articles of Historical Interest from *Physics Education 1966-80.*

1966	1	1	11-18	F C Frank	*Reflections on Sadi Carnot*
	1	2	69-78	E N da C Andrade	*A physics research student at Heidelberg in the old days*
	1	4	213-222	D McKie	*The rise of scientific societies and periodicals*
1967	2	1	3-12	T Martin	*Early days at the Royal Institution*
	2	3	140-145	S E Hunt	*The development and application of the Van de Graaff accelerator*
	2	6	297-305	A J Woodall	*Science history*
	2	6	317-323	L Carmichael	*America's Smithsonian today*
1968	3	3	115-119	R Schofield and D Harding	*The teaching of physics over fifty years and more*
	3	3	119-120	L E Higson	*Physics teaching in the early twentieth century*
	3	3	120-121	K E Parks	*The teaching of physics in girls' schools*
	3	5	225-232	H R Post	*Atomism 1900 I*
	3	6	307-312	H R Post	*Atomism 1900 II*
	3	6	315-316	D W Harding	*Names in physics: Abbe*
1969	4	1	46-48	D W Harding	*Names in physics: Brillouin*
	4	2	106-113	B Gee	*Names in physics: George Simon Ohm 1789-1854*
	4	3	160-161	D Andrew	*Names in physics: Johannes Kepler 1571-1630*
	4	3	167-172	N Drysdale	*Physics at Heidelberg*
	4	4	229-230	M L Cooper	*Names in physics: Foucault*
	4	5	283-285	A J Woodall and A C Hawkins	*Laboratory physics and its debt to G F C Searle*
	4	6	341-343	A S Everest	*Names in physics: Kirchhoff 1824-1887*

1970	5 1	34-36	C Money	*The life and work of Sir Charles Wheatstone*
	5 2	84-85	L V Smith	*Names in physics : Joseph Henry 1797-1878*
	5 3	175-177	M L Cooper	*Names in physics: Fresnel*
	5 4	214-220	N C Flower	*Ernest Rutherford's experiments on thorium*
	5 4	229-231	E Deeson	*Names in physics: Hertz*
	5 5	280-287	C M Jarvis	*Nikola Tesla and the induction motor*
	5 6	359-369	B Gee	*Names in physics: Andre Marie Ampere 1775-1836*
1971	6 1	18-19	E S Gillespie	*Names in physics: C J Doppler*
	6 3	167-170	E Deeson	*Names in physics: Hooke*
	6 4	216-217	P E Lafferty	*Names in physics: Enrico Fermi 1901-54*
	6 6	419-422	D F Manley	*Names in physics: Blaise Pascal 1623-62*
1972	7 1	37-40	E Deeson	*Names in physics: Edmond Halley 1656-1742*
	7 1	50-52	B Gee	*The role of history of physics in physics education (report on IUPAP seminar July 1970)*
	7 1	53-57	B Gee	*Some suggestions for the use of the history of physics in a physics course*
	7 1	58-60	R L Krans	*The history of physics in the education of physics teachers*
	7 3	170-172	D J Jacobs	*Names in physics: Lord Rutherford*
	7 6	371-374	J L Hawes	*Names in physics:Rene Descartes 1596-1650*
	7 7	427-428	E S Gillespie	*Names in physics: Osborne Reynolds*
	7 8	471-478	W E Gross	*Joseph Henry and the American Philosophical Society*
	7 8	521-522	B Gee	*The role of the history of physics in physics education*
1973	8 2	102-105	G A Cox	*Names in physics: John Harrison*
	8 6	368-373	J M Gregory	*Physics teching in the late nineteenth century: a case history*
	8 6	396-399	G A Cox	*Names in physics: Thomas Young 1773-1829*
	8 7	455-458	J R Ravetz	*The Copernican Revolution - from then to now*
	8 7	488-494	G E Perry	*Lunar exploration: 1958-1973*
1974	9 4	265-268	A T Jackson	*Detection of the ether*
	9 4	275-278	B Davies	*Names in physics: Edme Mariotte 1620-1684*
	9 5	336-337	T P Swetman	*Mach's principle*
	9 7	452-458	G S Leadstone	*Maskelyne's Schehallien experiment of 1774*
1975	10 1	45-49	A F Chalmers	*Maxwell and the displacement current*
	10 2	85-90	B Gee and M Ebison	*Books on the history, sociology and philosophy of physics*
	10 4	322-325	B R Chapman	*Nostalgia - or nous? A look back at an early text-book*
	10 5	357-360	J A D Matthew	*Names in physics:Erwin Schrodinger*
	10 6	457-460	G D Goehring	*17th century treatments of one-dimensional collisions*
	10 7	517-521	D L Simms	*Archimedes and burning mirrors*

1976 11 5 373-377 G B Brown *Newton, language and mass*
11 6 438-443 R C Dougal *The presentation of the Planck radiation formula*
11 7 481-482 D P Newton *Names in physics:Francis Bacon 1561-1626*

1977 12 2 92-96 G D Bishop *The early scientific instrument makers*
12 5 326-328 A J Walton *The Kelvin-Thomson atom part 1: the one-to six-electron atoms*
12 6 339-340 P M Rattansi *Isaac Newton - 250th anniversary*
12 6 340-346 B Gee *A Newtonian miscellany*
12 6 347-350 B Gee *Gravitation as Newton first saw it*
12 6 351-353 J L Hawes *Newton, particles and concepts of force*
12 6 354-356 G Cantor *Newton's telescope*
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lateral thoughts

Physics before physicists

This month the Science Museum in London opens a major new gallery, "Science in the 18th Century: the King George III Collection". One of its curators, **Alan Morton**, reflects on Georgian science's impact on the public

TODAY, with physicists playing an integral part in modern life, it is difficult to imagine that this is a very recent development. In the 18th century, there were few universities and little scientific research was carried out in those there were. Government support for science was very modest. Consequently, there were no career physicists. However, in marked contrast to the situation today, an important impetus for change came from members of the public who wanted to know about science. To meet their needs, public science lectures began in the early 18th century.

Around the same time courses sprang up on medicine, chemistry, and mathematics, aimed at those who wanted to follow a career as a surgeon, pharmacist or navigator. But the new courses on natural philosophy – the 18th-century forerunner of physics – were different: they were not intended as a preparation for a career but as a form of rational entertainment. Within a generation or so natural philosophy courses were taking place in cities across Europe. From these modest 18th-century roots have developed many of the features of modern science.

In London, Francis Hauksbee and J T Desaguliers were among the first to offer courses on natural philosophy. Those attending paid $2\frac{1}{2}$ guineas a course, a considerable sum in those days (a skilled furniture maker, for example, only earned about five guineas a week). But as well as catering for this audience, Hauksbee and Desaguliers were curators of experiments at the Royal Society during the time that Isaac Newton was president. First Hauksbee and then Desaguliers had responsibility for demonstrating new experiments to fellows of the Royal Society.

Often these experiments were repeated at a public lecture. It was through this channel that the views of Newton on gravitation or the nature of light, for example, were broadcast to a general audience. To attract this audience, the lecturers made a point of using dramatic working demonstrations. But these demonstrations had a further advantage: they helped to convince the patrons of the correctness of such new ideas without the use of mathematics (which would almost certainly have driven them away).

Some demonstrations were quite elaborate. For example, Desaguliers complained about "pompous orreries" used to show the motion of the Solar System. These models were first produced in the early 18th century to demonstrate the arguments of Galileo and Newton about planetary motion around the Sun. But large and elaborate orreries were made which demonstrated more about the wealth of the owner than anything else.

But even with this burgeoning interest, the number of people who could earn a living from science in the mid-18th century was very small. In the 1740s, when Desaguliers looked back on his life as a lecturer, he estimated that altogether there were 13 people lecturing throughout Europe, of whom nine had been his pupils. These figures, though probably an underestimate, indicate both the small size of the enterprise and the extent of Desaguliers's influence.

Apart from lecturing, there were few other openings for individuals with a scientific bent; there were posts as professors of natural philosophy at the two universities in England and the four in Scotland; and a small handful of others at the Royal Observatory at Greenwich or the Military Academy at Woolwich. Apart from those, there were a few teaching posts in schools or as private tutors.

Some of the vagaries of a lecturing career in the 1750s are illustrated by the experiences of Stephen Demainbray, whose apparatus is now on display at the Science Museum as part of the King George III collection. Demainbray learnt his trade from Desaguliers and began lecturing in Edinburgh. After a tour through the north of England, he went to Dublin and then on to Bordeaux and other towns in France before settling in London in 1754. On his travels he collected a wide variety of model machines, and his collection provides a unique snapshot of science and technology on the eve of the industrial revolution.

But back in London his fortunes were mixed. He had the good luck to be engaged as a natural philosophy lecturer to the younger members of the royal family, including the future George III. But he also found that public enthusiasm for natural philsophy was waning. Then, as now, practitioners of science lamented the deplorable lack of public interest. In 1759 Benjamin Franklin cautioned one correspondent about the insecurity of making a living by lecturing, his pessimism prompted by the case of Demainbray. According to Franklin, "Mr Demainbray, who is reputed an excellent Lecturer, and has an Apparatus that cost nearly £2000, the finest perhaps in the World, can hardly make up an audience in this great City to attend one Course in a Winter".

Demainbray complained himself about the "inattention" his countrymen paid to scientific pursuits. In an attempt to attract more subscribers to his lectures he offered a course on natural history, but that too was unsuccessful and by 1761 he had given up lecturing altogether to become an official of the Customs and Excise, a much more lucrative employment.

However, the royal connection that Demainbray had established eventually stood him in good stead: when George III had his own private observatory built (now known as Kew Observatory), Demainbray became its superintendent. As a result, Demainbray's lecture apparatus became amalgamated with that belonging to the royal family.

George III's observatory was built to observe the transit of Venus in June that year. By observing Venus move across the Sun's disc from different points on the Earth's surface, the size of the Solar System could be estimated. This project caught the imagination of the members of many scientific societies and, in an early example of international collaboration, expeditions were sent to different parts of the globe to observe the transit. In Britain, the Royal Society successfully petitioned the King for funds to send an expedition to the South Seas. Captain Cook's first voyage to Tahiti was the result.

It is from such 18th-century activities that we can discern some characteristics of modern science, such as the development of lectures and working demonstrations as a way of teaching, and also the functions of scientific societies. But, on reflection, what is truly remarkable is the scale of the scientific enterprise that has emerged from such modest Georgian antecedents.

Alan Morton is Honorary Secretary of the IOP History of Physics Group and is a Senior Curator at the Science Museum. A catalogue, *Public and Private Science: The King George III Collection* by Alan Morton and Jane Wess, has just been published by Oxford University Press.