Institute *of* Physics

History of Physics Group

Newsletter

No 12 Spring 1999

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Editorial

Welcome to the 1999 issue of the History of Physics Group Newsletter. I'd like to thank my predecessor, Bob Joyce, for his sterling work on previous issues, and for the help he has given me in taking on this new role. From the Chairman's and Secretary's addresses, it is clear that we have had a productive year, and we are ending the Millennium with a large membership and an increased presence on the World Wide Web. We always value your feedback about any of the Group's activities, so if you have an opinion you would like to express, then please do e-mail or write to us. Contact details can be found on page 4.

In this anniversary year for the Institute, we have more on the Blue Plaques for Physicists scheme, including how ***you*** *can help just by taking a photo. We have two articles on the subject by Malcolm Cooper, one about the Blue Plaques in the Lancashire and Cumbria Branch, and the other a humorous look at why it might be a good idea to have some more of them, entitled "Who?".*

We also have several items associated with past meetings of the Group. Following on from our successful Vectors meeting, we have an article by Hugh Montgomery on the life of William Rowan Hamilton. For those of you who missed the meeting on Electromagnetic Fields held this October, the talk given by Dr. John Roche on Concepts of the electromagnetic field in the twentieth century has been written up in this issue, starting on page 29. Our feature article is about a very unusual carpet with physics connections.

Starting on page 32 you'll find details of future meetings arranged by this Group, followed by listings of lectures and conferences in Britain and abroad that may be of interest.

I hope you enjoy browsing through this newsletter, and, as ever, if you have any comments, ideas or material you would like to submit for future issues, please do let me know.

Dates for your diary:

- Monday 8th March (evening)
- Saturday 24th April
- Saturday 23rd October

Lucy Hudson

History of Physics Group Committee:

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	Mr. H. Montgomery
	Dr. C. Ray
	Dr. P. Rowlands

Chairman's Report

This has been a vigorous year for the group. We held our annual planning meeting on 14th February 1998 at the Science Museum. We had a very full turnout of committee members. Planning meetings are generally about discussing meetings two years ahead and this was a particularly successful meeting in this respect. Important policy changes were also introduced, the most important of which was to appoint a three-man planning team for each future meeting.

Bob Joyce informed us that he could look after one further issue of the Newsletter but that he would then have to resign as Editor. I am sure I am echoing the feelings of all of our members in stating how much we appreciate his professionalism. More than one member of the History of Physics Group has expressed their appreciation to me in writing for the quality and content of the Newsletter. We are very fortunate, indeed, that Lucy Hudson has agreed to take over the Newsletter. **Raj Williamson** is also resigning from our committee. Raj has been of enormous importance to the History of Physics group. She was a founding member, was extremely active and supportive on the committee, organised a series of wonderful and very well attended meetings and even published a collection of articles based on these meetings, *The Education of a Physicist*. She will be greatly missed. I do hope, if her circumstances change, that she may consider rejoining the committee. **Alan Morton** is, sadly, also resigning from the committee. Alan introduced the tradition, which has been so enormously beneficial for the Group, of curators at the Science Museum acting as Honorary Secretaries of the Group. His very helpful contributions to Group and committee meetings will be much missed.

We have had three very interesting meetings this year. An afternoon meeting on Aspects of the History of Measurement was held in The National Physical Laboratory at Teddington. There were 50-60 in attendance, bolstered by the participation of the Glazebrook Society in the meeting. Professor Robert Hedges of the Archaeological Research Laboratory, Oxford, spoke on measuring archaeological time. Dr Douglas Ambrose spoke of his years as editor of Kaye and Laby; Dr Brian Petley spoke of the history of electrical units; Dr Anita McConnell spoke of the history of standards of mass and time and then took us on a tour of the N.P.L. Museum. On 14th September an evening lecture was given in 76 Portland place on The Evolution of Medical Imaging by Professor John Mallard and chaired by Christopher Green. It was a fascinating and very professionally prepared lecture and merited a much

larger attendance than it attracted. In October, we held a meeting on the changing concept of the electromagnetic field.

Two meetings have been prepared for 1999. One in Spring on Physics and Religion, a subject in which there is a rapidly growing interest, and one in October in the History of Science Museum, Oxford, to celebrate the Volta anniversary.

The History of Physics Group has an Internet page. There have been some difficulties updating this page but we now have now been provided with the tools to modify our own page.

It is high time for the old guard of the History Group to make way for fresh blood. Both Neil Brown and I will resign from our posts at the next AGM, although we will be happy to stay on the committee if you wish us to do so. We need to think about a suitable Chairman. Sir Brian Pippard and Professor A J Meadows were high profile physicists and gave the group considerable credibility. We must institute a search during the coming year. I would ask all members of the group to put forward suggestions to me or to Neil. I believe we have good reasons to look forward to improving organisation, an increasingly enthusiastic committee and highly interesting meetings for the coming year.

John Roche,
Chairman

Honorary Secretary's Report

The Secretary has little to add to the Chairman's remarks.

As well as the two main meetings being organized for 1999, the Group will be arranging an evening lecture. This will be at the Institute of Physics on Monday, 8th March. The speaker will be Professor Sir Joseph Rotblat, well known as the founder of the Pugwash conferences and for his work against nuclear weapons. On this occasion he will talk informally about the start of his scientific career in Poland.

The committee held two meetings last year. One meeting was in Manchester in October 1997 on the same date as the 'Entropy' meeting and AGM. The other, the main planning meeting, was held in London in February. We are pleased to welcome four new members elected to the committee at the AGM in October 1998. The committee had been relatively static for a long while, and it is good to have some 'new blood' to complement the 'old hands'. The new committee has met once since the AGM, to review the programme for 1999 and to start planning for the year 2000.

The Group has 398 members, and it is a continuing concern that only about ten per cent of the membership attends meetings or participates actively in any way. It is difficult to know whether the meetings and the newsletter are the sort of thing that members want. Any feedback on this would be welcome, as always. There have been changes in the way IOP headquarters interacts with Groups. At the Honorary Secretaries Meetings, we now receive much more information about activities at headquarters. It is not easy to know how to pass this on to group members, or even committee members, in a way is relevant. The financing of groups has been clarified, which is an improvement. Groups will have more funds in the next twelve months, which gives more flexibility in planning meetings and any other activities.

C. N. Brown,
Honorary Secretary.

The Group's Website

We now have the ability to edit our own website. This means that we can use it to provide you with up-to-date information on activities organised by the group. So if you're considering coming to a meeting, but need more information, it's worth checking on the internet.

The address is …

www.iop.org/IOP/Groups/HP/

Do visit it if you have internet access. Among other things, the site also includes a collection of websites connected with the history of physics. After this anniversary year, it will also include details of the Institute's Blue Plaques to Physicists.

* * *

The Mathematics of Measurement: a critical history

This is a new book by our chairman, Dr. John Roche. It has just been published in hardback by The Athlone Press, who say:

Hitherto, there has been no history of the branches of mathematics which have been specifically developed for the handling of measurements. Dr. Roche now fills this gap with an account which treats dimensional analysis, the quantity calculus, the base calculus, the calculus of error analysis, etc. It also uses the insights of historical study to clarify and solve well-known difficulties in the present-day mathematics of measurement. The primary readership will be among physicists, engineers, mathematicians and historians of science.

Priced at £65, its ISBN is 0 485 11473 9.

If you have a book or other work relating to the history of physics which you would like to publicise, please send me the details and I'll include them in the next newsletter.

Books and maps covering places of historical scientific interest

Dennis and Sylvia Rosen (1994) London Science, Prion
ISBN 1-85375-140-5 RRP £14.99 224 pp.

This is a beautifully produced hardback, covering museums, libraries, and places of scientific, technological and medical interest. It has glorious colour pictures, useful information (such as phone numbers and opening hours), and suggests a series of scientific walks around London. The only drawback is obvious from the title – it is only about London, and it is a shame that there is no similar book for the whole of the UK.

Trevor I. Williams (1996) Our Scientific Heritage: an A-Z of Great Britain and Ireland, Sutton Publishing
ISBN 0-7509-0820-3 RRP £20.00 250 pp.

This is a different type of book. It has the obvious advantage of covering a greater geographical area than just London, and also a greater subject area (science, technology, archaeology, medicine and engineering). It seems to be a pretty comprehensive list of places of interest in these subjects, but there are no pictures, and often only a sentence or two about a particular place. Nevertheless, the huge number of entries can be searched by geographical location (there are maps), alphabetical order by person, or alphabetical order by place. There are also longer entries on places with very many sites of interest, such as Glasgow, Manchester and Dublin.

Charles Tanford and Jacqueline Reynolds (1995) A Travel Guide to Scientific Sites of the British Isles: a guide to the people, places and landmarks of science, John Wiley & Sons Ltd.
ISBN 0-471-95270-2 RRP £16.99 344 pp.

This pocket-sized book has a good selection of black and white photos, and again covers the whole of the UK. It has a good amount of detail, and starts with a short historical account of different branches of science connected with places in the UK. The main body of the book is a series of entries, grouped by geographical area, with information on, and pictures of, the places to see, but there are also location maps, and indexes of names, places and subjects.

London: city of science

This is a **map**, published by the British Library with support from COPUS (the

Committee on the Public Understanding of Science). On one side it has a map of London showing the locations of sites of interest, and on the other, a few words about what is to be found at these locations. My own copy was obtained in person (they were on display in the lobby) from:

Science Reference and Information Service
25 Southampton Buildings
LONDON WC2A 1AW
(0171) 412-7494

N.B. There is a note on the back of the map saying that all collections relating to science, technology and medicine will be moving in April 1999 to The British Library, 96 Euston Road, LONDON NW1 2DB; (0171) 412-7677

Sophie Huxley <u>The Oxford Science Walk</u>
ISBN 0-952-2671-0 1 £2.00

This is also a **map**, illustrated with attractive line drawings by Edith Gollnast. They can be bought in Blackwells, Oxford, and also from the Museum of the History of Science in Oxford (closed for renovation until the end of Summer 1999) or from the publisher: 'Science Walk Publications' 35 Marston Street, OXFORD OX4 1JU.

The National Portrait Gallery, London

The Royal Society has teamed up with the Gallery to produce a leaflet of those portraits on display with scientific connections. It is available from the Gallery.

*with thanks to **Kate Crennell***
for the last two items

Blue Plaques for Physicists

If, as I did, you always assumed that blue plaques were a national scheme, administered centrally, it might come as some surprise to you to learn that there are actually many different schemes in operation. There is a scheme administered by English Heritage for London, providing the familiar blue plaques to politicians, poets, not enough scientists, etc. Outside the Capital, it is up to local authorities to put up plaques, of whatever hue they desire; and even within London, it is perfectly acceptable for the Borough councils to erect their own plaques to their own specifications. The Institute of Physics has its own scheme, and, as you know, the History Group has been concerned with the Blue Plaques schemes, including those set up by the Institute itself. The following section of the newsletter has more on the subject, including details about what ***you*** can do to help the History Group's project for the Institute's 125th Anniversary.

"Who?"

Malcolm Cooper

Where was Sir Isaac Newton born? Well that's a fairly straightforward question you may think. And so it is to readers of this newsletter, but it was the question I posed myself about 10 years ago when I first joined the Institute and the History of Physics group.

So a quick check with the biographical dictionary revealed Woolsthorpe Manor, Lincolnshire, and pondering over the map I decided that a visit was long overdue. Driving down the A1, shock and dismay crept over me - where were the signposts? Where were the Brown Boards announcing:

Visit historic Woolsthorpe
Home of SIR ISAAC NEWTON

(Teas, snacks, gift shop)

But no. Nothing.

It may be different now of course, but I did finally find the house without too much difficulty, and pulled into the empty car park. I had arrived at the birthplace of one of the country's greatest scientists and where was everybody? Had this been Stratford-upon-Avon, the situation would be very different. The place would be heaving with tourists wandering about bristling with cameras and clutching guidebooks. Bookshops and museums might be selling titles like:

"The Complete Works of Newton" or "The De Luxe Illustrated Principia" or "Opticks for Everyman"

At the car park entrance there was a board quietly informing visitors that this was the birthplace of Sir Isaac Newton. Now to be entirely selfish, I wouldn't have it any other way, but I idly wondered how many people chancing upon this beautiful spot would think – "Who?".

Returning home I decided that I should conduct a straw poll among some friends and colleagues to see if the question could be answered.

It was. About a third had not even heard of him, and of the remainder, about 80% said something like "Oh, yes. Something to do with apples falling wasn't he?" Only a few knew of what he achieved and, incidentally, when. Now, it may be that this gives an unfair picture of the nation's awareness of such figures? But I fear not.

The article on blue plaques in last year's issue suggests more should be done, and indeed it was heartening to see the list of several physicists honoured in this way in the last issue, but this can only be a part of raising public awareness of our national scientific heritage.

And what about our international heritage? I don't know but a couple of years ago my wife and I were on holiday in Bavaria so we thought we'd take in a visit to Ulm, the birth town of surely the most famous name in physics and in science generally - Albert Einstein. Enquiring at the local tourist information centre, in our admittedly faltering German, "Bitte, wo ist die Geburtshause von Einstein?", we discovered that the house had been destroyed during the war but that there was a monument on the site.

But when asking about a plaque featured in a tourist leaflet of Ulm there was great consternation and conferring amongst colleagues before we were told … it was right next to the monument! Interestingly this plaque was a gift from India through the Calcutta Arts Society!

Later during the holiday we went to Vienna where (among other things!) I wanted to see the grave of Ludwig Boltzmann, and so into the tourist office we went:

“WHO?”
“BoItzmann. Ludwig Boltzmann.”
"Is that with a ‘B’?”
“Yes. He was a famous physicist.”

Well they were really very efficient; down came The Big Book, pages turned, and a gasp of pleasure when the entry was found. And they promptly described how to get to the cemetery where he was buried - even the plot number -14c!

Which was more than could be said of the tourist information centre in Edinburgh. “Can you tell me where James Clerk Maxwell was born, please?”

Yes, - you've guessed it!
“WHO?” with a totally blank look

Well by this time I'm either in that resigned mood or jumping up and down - well almost.

This is not intended to be a tirade against tourist information centres (although it does indicate, I think, that training is lacking in some) but it did demonstrate what I know is well known, in a very obvious if simplistic way, that ignorance is alarmingly widespread; not only among the general public but also among those who are in a position to pass on information to a wider audience.

I think it was the look of total disinterest on the assistant’s face when I said, “Yes, one of Scotland’s greatest scientists.”

But it’s not always like that. I felt somewhat daunted arriving at the old cemetery in Sale in search of the grave of James Prescot Joule. On enquiring rather hesitatingly of the sexton, he said “Oh, yes. Come this way, I’ll show you. We get all sorts asking after it. I've had 'em from France, America, even Japan!”

Where next? Haven't decided yet!

IOP 125th Anniversary: *your* contribution

As part of the 125th Anniversary commemorations, we are hoping to gather a nationwide database of information on places to visit which have connections with physics. This information will be put on the Anniversary website. Although we appreciate that many people do not have internet access, a website is a good start. Once the information exists, it may be possible to persuade somebody to print all the entries as a booklet.

Could *you* spare the time to take a photo of your local IOP blue plaque?

We would ideally like you to take a photo of the location of your local blue plaque (listed overleaf). This would then be put together with a couple of paragraphs about the place and the connections that it has with physics. Because of copyright, it is essential that the photo is taken by somebody who is willing to relinquish copyright of that photo so that it can be put on the website without incurring extra costs. As you may well remember, we had a large amount of biographical information in the newsletter last year, so it may well not be necessary for you to do any writing at all, unless you would like to.

If this information is available on the Internet, then many schools will be able to access it (perhaps for a class visit by a physics class?), or physicists on holiday may chose to take a detour to look at a physics place for twenty minutes. It will be possible to send paper copies of appropriate information to tourist offices, with photocopying permission; and those offices with internet access (yes, there are some!) will be able to print out their own. The information will also be printed in the History Group's newsletter, so members of the group who do not have internet access will be able to cut-out-and-keep their own copies.

If you feel you can spare the time to take a photo, **please** contact me:

Miss Lucy Hudson
11 Jewel Road
LONDON E17 4QU
0181 520 9457
lucy.hudson@bbc.co.uk

For this year, it is proposed to gather information on only the Institute's own plaques, but there are many other interesting places with connections to physics and physicists in the UK, and if we get a good response, it would be very helpful to have information on these as well.

Plaques sponsored by the Institute of Physics:

- Sir Edward Appleton (1892 - 1965) the Old Building of the Bradford and Ilkley Community College, West Yorkshire
- John Logie Baird (1888 - 1946) the house in Hastings where Baird carried out his experiments, Sussex
- Sir William Henry Bragg (1862 - 1942) the Parkinson Building, University of Leeds, West Yorkshire
- Nicholas Callan (1799 - 1864) Callan Hall, St. Patrick's College, Maynooth College, Co. Kildare, Ireland
- John Canton (1718 - 1782) near the main door of the Old Town Hall in the Shambles, Stroud, Gloucestershire
- John Dalton (1766 - 1844) Stramongate School, Kendal, Cumbria
- Sir Arthur Eddington (1882 - 1944) Stramongate School, Kendal, Cumbria
- Daphne Jackson (1936 - 1991) 5 St. Omer Road, Guildford, Surrey
- Sir Oliver Lodge (1871 - 1940) a row of houses called "The Views", Penkhull, Staffordshire
- James Clerk Maxwell (1831 - 1879) Strand Building, King's College, London
- Sir Charles Parsons (1854 - 1931) in the main entrance to the Turbinia Gallery of the Newcastle-upon-Tyne Museum of Discovery, Teeside
- Joseph Priestley (1733 - 1804) Warrington Salvation Army Citadel, Cheshire
- Frederick Soddy (1877 - 1956) Eastbourne College, Sussex
- Edmund Stoner (1899 - 1968) the Physics Building of the University of Leeds (now known as the Stoner Building), West Yorkshire
- William Thomson, Baron Kelvin of Largs (1824 – 1907) University of Glasgow
- Ernest Walton (1804 - 1995) Trinity College, Dublin, Ireland
- Evan James Williams (1903 – 1945) the house where he was born and died, near Swansea, South Wales
- C T R Wilson (1869 - 1959) on a specially-built cairn at Flotterstone in the Pentland Hills, south of Edinburgh, Scotland

Blue Plaques in the Lancashire & Cumbria Branch*

Malcolm Cooper

On a wild, wet and windy day in March, members of the Kendal Civic Society, the Institute of Physics and the Royal Astronomical Society met to attend the unveiling of a plaque to commemorate John Dalton and Sir Arthur Eddington.

The plaque [Fig. 1], in fact green, part of a series of 30 erected by the Kendal Civic Society to honour local worthies, was jointly sponsored by the I.O.P. and the R.A.S.. It is mounted on a wall near the site of the old Quaker School in Stramongate, Kendal, where John Dalton taught from 1781 to 1793.

Figure 1: Plaque to John Dalton and Sir A.S. Eddington

Coincidentally, Eddington's father was the headmaster at the school about a hundred years later and so it was here that his son, Arthur Stanley Eddington, was born in 1882. He was only 2 years old when the family moved to Somerset, following the tragic death of his father in the typhoid epidemic of 1884.

John Dalton was born about September 5th, 1766, in the small village of Eaglesfield near Cockermouth, Cumberland (now Cumbria), in a tiny cottage which already bears a plaque over the doorway commemorating his birthplace. There is also another plaque to him installed by the Royal Society on the local Church.

The branch, especially through the efforts of Vice Chairman, Dr. Ian Ferguson, has been actively pursuing a number of other 'candidates': Edward Troughton (instrument maker), John Desmond Bernal, Sir John Ambrose Fleming and Sir William Henry Bragg. My own involvement has been with the early years of William Bragg [Fig. 2] who was born and brought up near Wigton, Cumberland.

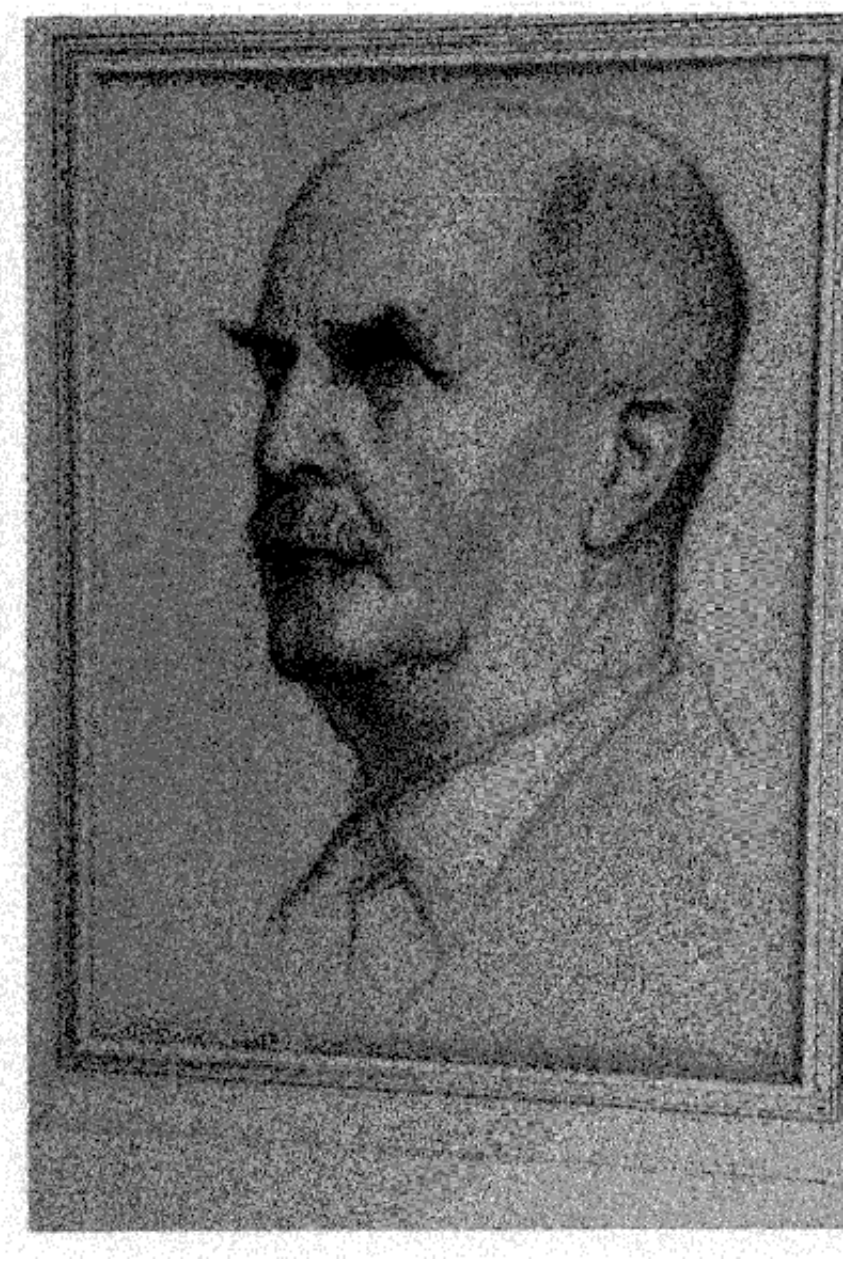

Figure 2: Portrait of Sir William Henry Bragg, painted in 1934

His father, R J Bragg, was a merchant seaman sailing out of Workington and later Liverpool to the Far East. He gave up the sea in the late 1850s to settle down as a yeoman farmer at Stoneraise Place [Fig. 3], in the little village of Westward, Cumberland (NY274457).

Figure 3: Stoneraise Place, Westward, Cumberland

It was here that he met his future wife, Mary Wood, daughter of the Curate of St Hilda's, Westward. They were married on 27th June 1861, the service being conducted by his future father-in-law, Robert Wood! William Henry Bragg, their first son, was born on July 2nd 1862 and his two brothers, Robert John and James Wood were born in 1864 and 1866 respectively. Their childhood seems to have been a very happy one and even after William went to live with his uncles in Market Harborough, Leicestershire, he made frequent visits to Stoneraise Place during the school holidays.

Adjoining the rear of the house are barns, one part of which may have been used as a 'den' for the Bragg brothers [Fig. 4] and there are still today inscriptions on the beams and drawings on the whitewashed walls, including cartoons and symmetrical patterns [Fig. 5]. Unfortunately there is no evidence that the drawings were done by the Bragg brothers, but it would seem to be quite likely.

Figure 4: den for the Bragg brothers?

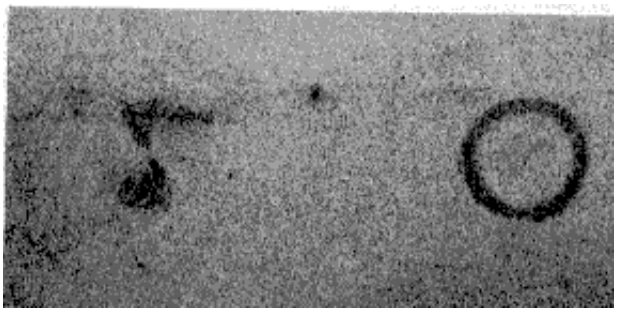

Figure 5: Their artwork?

On his father's insistence, William attended King William's College, Isle of Man, (there were family connections with the school) and in the spring of 1880 he was awarded an Exhibition at Trinity but in fact did not go up to Cambridge until the following year.

Interestingly there is already a plaque on the house commemorating his birth (thought to have been placed there by his family) but it unfortunately gives little detail. The house is well set back from a very minor road and so it was decided that no further action as regards a new plaque could be supported. However it good to note that a blue plaque has been unveiled to Sir William on the Parkinson Building, University of Leeds, where he held the chair in physics after his return from Adelaide in 1909.

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*My thanks to **Mr. & Mrs. Hunter**, the present owners of Stoneraise Place, for kindly allowing me to photograph the house and barn, and thanks to **Tully House Museum** for their kind permission to reproduce the portrait of Sir William.*

Acknowledgements to "William Henry Bragg, 1862-1942, Man and Scientist" by G M Caroe for the details of his early life.

Crystallography on a Carpet*

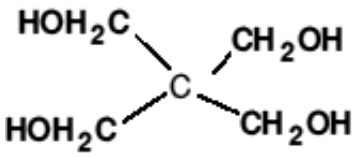
John Robertson, University of Leeds

At the recent BCA meeting in Leeds, John Robertson provided a historical exhibit with many photographs of early Leeds crystallographers, the Braggs' original camera and notebook containing his early X-Ray photographs, and a crystallographic carpet accompanied by the story below. Several retired crystallographers visiting the Poster Session reminisced about the times when Gordon Cox had called them into his office for 'discussion' while they stood on this very carpet. Over the years parts had become worn; the whole carpet was about to be consigned to oblivion in a waste skip during office renovations in the Chemistry Department at Leeds when John Robertson managed to rescue it, cut out the worn parts and have it cleaned and rebound to make the much admired carpet we saw at the Poster Session.

The carpet at the poster session in Leeds
Photograph by Richard Glazer of Oxford Cryosystems

This carpet depicts the **crystal structure of Pentaerythritol, $C(CH_2OH)_4$**. Sixty years ago, pentaeryritol made an interesting contribution to the correct understanding of the tetrahedral valency of carbon. During the 1920's there had been controversy over the spatial distribution of the bonds around an aliphatic carbon atom. Direct measurement of C-C bonds at that time had been possible only for some aromatic compounds, plus a few oxalic acid derivatives. No reliable study of an aliphatic system had been made. Pentaerythitol was a test case for this study.

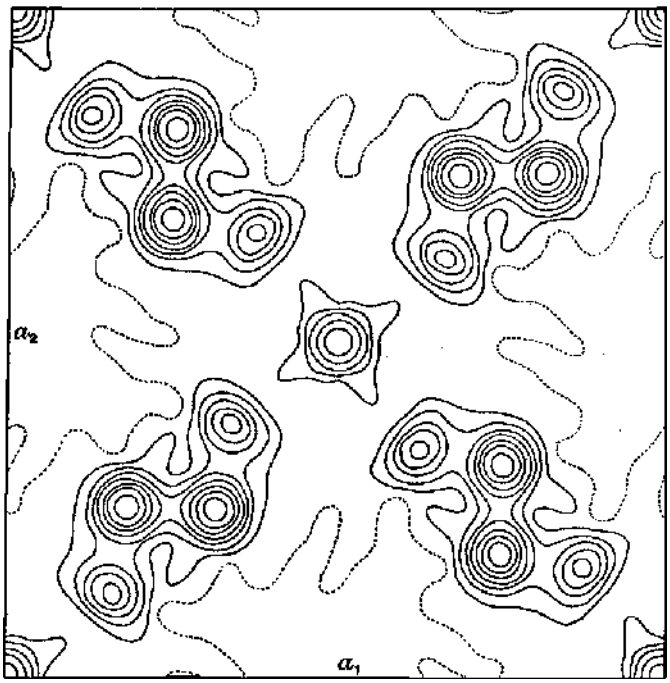
Today, we know its three-dimensional structure to be:



However, in those early days of stereochemistry, a paper had been published in 1923 which had claimed that the four bonds in this molecule were planar, directed to the four corners of a square. This controversy was discussed in the British Chemical Society's Annual Reports of 1929.

It was Gordon Cox and his co-workers (Llewellyn and Goodwin) at the University of Birmingham who put this matter right. (This was prior to Cox's appointment, in 1945, to the Chair here in Leeds) They carried out a 3-dimensional X-ray crystal structure analysis of pentaerythritol, showing conclusively that the four C-C bonds were not planar at all but were directed towards the four vertices of a regular tetrahedron. This was long before computers, and before even Beevers-Lipson strips were available. In those days it was one of the first 3-D analyses of crystal diffraction. The paper was published in J.Chem.Soc., in 1937 (page 883-). Cox's Fourier projection, a view down the 4_2 symmetry axis, based on the x,y coordinates of all the atoms, is reproduced overleaf.

The central carbon atoms lie on S_4 axes. Around a different set of S4 axes the four hydroxyl groups, from four separate molecules, are hydrogen-bonded to one another in squares. The four C-C bonds from the central atom look planar in this projection but, in fact, two opposing bonds point upwards while the other two point down. The essentially perfect tetrahedral symmetry of these bonds was derived from the 3-D coordinates, x, y, z, of the five carbons.



So how did all this chemistry get onto a carpet?

In 1951, during the prestigious '**Festival of Britain**', when leading industrialists from all parts of the UK were displaying their latest and best creations, crystal structure patterns were much-sought after, as exciting new designs for textiles, ceramics and other materials. *JAMES TEMPLETON, Ltd*, a carpet manufacturer in Glasgow, produced this unique carpet with its historic crystal structure pattern, specially for the exhibition in London. Then, following its display at the Festival, the carpet was proudly acquired by Professor Cox for his room in the School of Chemistry here (from 1952-60).

* *This article first appeared in* Crystallography News*, the quarterly journal of the British Crystallographic Association, Number 61, June 1997. It has been reproduced here with the permission of the Editor.*

William Rowan Hamilton: a short biographical sketch

Hugh Montgomery

Mathematical Physics is an exacting discipline. When someone spends the whole of his life working in this field he usually does so out of a deep sense of commitment, and a feeling that the choice was inevitable. However for the Irish scholar William Hamilton the exact opposite seems to be the case; as a young man his talents might have taken him in any of a number of directions, and it was only in his mature years that his commitment to science was complete.

William Rowan Hamilton was born in Dublin in 1805. He was the only son of Archibald Hamilton, a solicitor who was himself born in Scotland, although he had lived in Dublin for most of his life. When his son was three years old Archibald ran into political and financial difficulties, and William was sent to live with his uncle James Hamilton at Trim in County Meath, which lies about 30 miles to the north-west of Dublin. James was a curate in the Church of Ireland, and headmaster of the diocesan school at Trim; in this capacity he was responsible for the whole of William's schooling. His educational methods seem to have been authoritarian but effective, and under his tutoring William soon developed a prodigious talent for languages. At the age of seven he was reading Hebrew, and this was soon followed by fluency in Latin and Greek; this laid the foundations for a life-long interest in classical literature. When he was 13 William claimed to have mastered one language for each year of his life; these included the major European languages, but he also had some grasp of Persian, Chinese and Hindi. (There was some idea that he might take up a post in the East India Company.) In 1823 he entered Trinity College, where he twice gained the Vice Chancellor's Prize for English verse. In later life he developed a strong friendship with Wordsworth and to a lesser extent with Coleridge, and it was the latter who introduced him to the philosophy of Kant.

William had acquired an early taste for mathematics during his schoolboy days at Trim, and at the age of ten he devoured a Latin copy of Euclid's Elements. James Hamilton did not discourage his nephew in this area, but he tried to limit his mathematical studies to books which were thought to be useful for the Entrance Examination at Trinity. Fortunately William escaped from his uncle for a time in the summer of 1822 when he visited Dublin, and

he obtained much better guidance from Charles Boyton, the recently appointed Fellow in Mathematics at Trinity College. Ten years earlier the teaching of mathematics at Trinity had been radically reformed by Bartholomew Lloyd, who introduced continental methods at a time when Cambridge was still toiling in the Newtonian straitjacket. Boyton lent William a copy of the Mécanique Céleste of Laplace, and the 17 year-old found an error in one of the propositions. He also solved a problem in Analytical Geometry which was baffling Boyton at the time, and when William entered Trinity a year later his mathematical education was in good hands and advanced rapidly.

However at this stage in his career, it was still not clear to William that he was destined to be a mathematician. The usual aesthetic pursuit for a scientist is music, but this meant nothing to him at all. On the other hand he did think about a career as a classical scholar, and more seriously he considered devoting himself to English poetry. In 1825 he sent some of his verses to Wordsworth, whose advice was harsh but valuable. The writing of poetry required far more than poetic instincts, and young Hamilton would never succeed in that area. William also sent some of his poems to Arabella Lawrence, a friend of Coleridge, and she found them "obscure and unrevealing". These criticisms were well taken on William's part, and his reply to Arabella reveals clearly his youthful dilemma:

> "It is the very passionateness of my love for Science which makes me fear its unlimited indulgence. I would preserve some other taste, some rival principle; I would cherish the fondness for classical and elegant literature which was early infused in me by my uncle to whom I owe my education - not in the vain hope of eminence, not in the idle affectation of universal genius, but to expand and liberalise my mind, to multiply and vary its resources, to guard not against the name but the reality of being a mere mathematician."

Despite his misgivings, Hamilton's powers as a mathematician flowered brilliantly during his undergraduate years. He was extremely successful in examinations, but this did not prevent him from pursuing his own original thoughts. In fact all the work which later made him famous, particularly in geometrical optics and mechanics, germinated during this period. Shortly before he graduated he was made Professor of Astronomy at Trinity, which carried with it the position of Astronomer Royal and Director of the Observatory at Dunsink near Dublin. By modern standards this appointment is astonishing, and it was controversial even at the time; Hamilton had a clear potential in mathematical research, but he had no experience or skill in handling astronomical equipment. However the position suited him in a curious way, because it provided a steady income and a house at Dunsink, and it gave him time and opportunity to develop his mathematical ideas.

Hamilton was in essence a lonely thinker, and the relative isolation of Dunsink was more congenial to him than the company of other mathematicians. For six years he shared the house at the observatory with his sisters, and in 1833 he married Helen Bayly and they brought up a family of two sons and one daughter.

It was during these early years at Dunsink that possibly his best work was carried out. He developed a new mathematical approach to geometrical optics, which led among other things to the prediction in 1832 of the phenomenon of conical refraction in biaxial crystals. When Humphrey Lloyd managed to demonstrate this effect two months later the scientific world was deeply impressed, partly because Hamilton's work was purely abstract and made no appeal to empirical data. In 1835 this achievement won for him the Royal Medal of the Royal Society, and also a knighthood from the Lord Lieutenant of Ireland.

Hamilton then began to develop a formal analogy between the wave theory of optics and Newton's theory of particle mechanics, which led to a radical reformulation of both subjects. In the nineteenth century this was regarded as a brilliant mental construct without much practical application; as Hertz pointed out Hamilton did not unite optics and mechanics in any physical sense, and the two subjects continued to develop independently. However this situation was completely transformed by the quantum revolution, and Hamilton’s formalism has become the foundation stone of the formal theory of quantum mechanics.

From the point of view of a modern physicist, Hamilton's work is remarkable for its complete lack of an empirical base. He did not have, nor claim to have, the deep intimate knowledge of the physical world which one finds in a Faraday or a Maxwell. He was a metaphysical thinker, constructing purely abstract mental systems, and as a Kantian Idealist he believed hat these systems must clarify and illuminate the empirical world. Nor did he believe - and here Faraday and Maxwell would agree with him - that the primary aim of Science was to improve the material well-being of humanity. As the years passed the absurdity of his position as Astronomer Royal became increasingly apparent, and his work at the observatory more and more perfunctory. His conscience was smitten by critical reports from the Board of Fellows at Trinity, and in 1843 his friends made the eminently sensible suggestion that he should apply for the vacant Chair of Mathematics. However, this application was opposed by the Board of Fellows, on the grounds that his work at the observatory was not satisfactory. This surely is a perfect example of the Peter Principle, by which a man is always promoted up to the limits of his incompetence.

There were in fact deeper ironies in Hamilton's position. He was devoting his life to the creation of abstract and some would say useless ideas, at a time when his country was passing through the most bitter and tragic period of its history. Safe in the Nirvana of Dunsink, Hamilton and his family were protected from the political riots in the city, and the Famine did not touch them except in a very peripheral way. Hamilton was a Tory and an Anglican, but his sensitivity would not allow him to try to justify the situation which was unfolding. In 1846 he wrote to his friend Aubrey de Vere, who was doing valiant but hopeless work in the soup kitchens and fever sheds of Limerick:

> "Though I have been giving, and shall continue to give, through various channels whatever I can spare in the way of money to the relief of those wants, yet I am almost ashamed of being so much interested as I am in things celestial, while there is so much suffering on this earth of ours. But it is the opinion of some judicious friends, themselves eminently active in charitable works, that my peculiar path and best chance of being useful to Ireland, are to be found in the pursuit of those abstract and seemingly unpractical contemplations to which my nature has so strong a bent. If the fame of our country shall be in any degree raised thereby, and if the industry of a particular kind thus shown shall tend to remove the prejudice which supposes Irishmen to be incapable of perseverance, some step, however slight, may be thereby made towards the establishment of an intellectual confidence which cannot be, in the long run, unproductive of temporal and material benefits to his unhappy but deeply interesting island and its inhabitants."

One feels that by this time Hamilton was completely in thrall to his mathematical daemon, and could not have abandoned it whatever the circumstances. Ever since 1830 he had been struggling with the problem of expressing geometry entirely in algebraic terms, a process which had begun 200 years earlier by Descartes. In a two-dimensional space, directed quantities or vectors can be added and multiplied easily enough, but there was no clear way to do the same for vectors in three-dimensions, or triples as Hamilton called them. It is said that each morning his elder son would ask him with the persistence of youth, "Can you multiply triples yet, Papa?", at which he would shake his head sadly, and reply, "No, my boy; I can only add and subtract them."

Hamilton was to wrestle with this problem for 13 years. On the 6th October 1843 he was walking from the observatory into Dublin, where he was to preside at a meeting of the Royal Irish Academy. Somewhere on that walk inspiration struck. As he later wrote to his son:

> "On the 6th day of October, which happened to be a Monday, and Council day of the Royal Irish Academy, I was walking in to attend and preside, and your mother was walking with me along the Royal Canal ...; and although she talked with me now and then, yet an *under-current* of thought was going on in my mind, which gave at last a *result*, whereof it is not too much to say that I felt *at once* the importance. An *electric current* seemed to *close*; and a spark flashed forth, the herald (as I *foresaw, immediately*) of many long years to come of definitely directed thought and work, by myself if spared, and at all events on the part of others, if I should even be allowed to live long enough distinctly to communicate the discovery. Nor could I resist the impulse - unphilosophical as it may have been - to cut with a knife on a stone of Brougham Bridge, as we passed it, the fundamental formula :
>
> $$i^2 = j^2 = k^2 = ijk = -1$$"

This passage has been quoted so frequently that it has acquired the status of an established myth. Unfortunately it was written 22 years after the event, in the year of Hamilton's death; memory can play strange tricks when so much is at stake. An earlier account which he sent to P.G. Tait is similar to the above, but differs in a number of details. Hence it seems likely that Hamilton did have a sudden inspiration at about this time, and it might well have been associated with a walk from Dunsink into Dublin.

Hamilton spent much of the rest of his life developing and promoting his new discovery, to which he gave the name quaternions. Their mathematical structure was transparent, although they invoked the revolutionary new concept of factors which fail to commute - i multiplied by j was not the same as j multiplied by i. Hamilton's great hope was that quaternions would be a vital key to the understanding of physics, but in this he was largely disappointed. One reason for this was that his book "Lectures on Quaternions", which was published in 1853, was almost unreadable because of its obscurity and verbosity. The only physicist who actively supported the use of quaternions was Peter Guthrie Tait, Professor of Mathematics at Queen's College Belfast and later of Natural Philosophy at Edinburgh. Nearly every other physicist felt that Hamilton (who was admired profoundly) had taken a wrong turning, and that quaternions were of no importance in physics.

Some of them were probably influenced by the fact that they did not share Hamilton's metaphysical beliefs. Hamilton seems to have taken this response philosophically, and towards the end of his life he wrote in a letter to Tait:

"Could anything be simpler? that we are on a right track, Never mind when. Don't you feel as well as think, and shall be thanked hereafter?"

Hamilton's personal life was not a happy one. His wife Helen was a semi-invalid, and she was unable to give him the sympathy and understanding he needed so badly. Their relationship was far removed from his ideal of romantic love, and it must have caused a great deal of pain to them both. Even at the practical level Helen was unable to make his life comfortable, and she exerted no control over the band of slatternly Irish servants who ran their household. His study was said to resemble a pigsty. Hamilton died in 1865; he had never complained about his wife's shortcomings, although for a number of years he had been sinking into serious alcoholism. This certainly undermined his health, but he maintained a prodigious intellectual output to the last. The parallels between Hamilton and Coleridge are considerable.

Sympathy for an individual should play no part in one's appraisal of a scientific theory. It is however gratifying to find that more than a hundred years after Hamilton's death, opinion is changing; some physicists (by no means all) feel that quaternion theory is a valuable tool in physics, and can be justified on strictly practical grounds. Many of Hamilton's ideas have been transformed almost beyond recognition, but his contributions to physics are secure.

Bibliography

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2. Stuart Hollingdale, Makers of Mathematics Penguin Books. London 1989

Concepts of the electromagnetic field in the twentieth century

by John Roche

John Roche introduced his lecture by arguing that modern concepts of the electric and magnetic field contain layer after layer put down during the past three centuries. Almost all of the older concepts in physics are like this. Many of these older levels are still active to some extent but are buried deep in the intuition of the physicist. He maintained that history is the only way of systematically uncovering all of the invisible levels of meaning in a concept of present day physics.

He went on to describe briefly Kelvin and Maxwell's mechanical ether theory; the theory of physical lines and tubes of force of Faraday, Poynting and J J Thomson; and the non-mechanical ether theory of Hendrik Lorentz. With the collapse of all ether theories in the 1920s, both Maxwell's and Lorentz's, ether theories of the field became untenable for the vast majority of physicists. Lorentz's theory was now the most successful and highly regarded theory in advanced electromagnetism and physicists sought for a way of preserving its main insights while dispensing with his ether theory. The history of the emergence of a new post-ether theory has yet to be written and what follows is necessarily a very rough outline and aspects of this interpretation may be flawed. A compromise theory seems to have emerged which combined elements of the Faraday/Thomson field theory with Lorentz theory. It is difficult to establish that this merging and modification of the two parent theories was developed by any single individual. It seems almost to have been a collective endeavour by the physics community negotiated semi-intuitively in countless publications, conferences, classrooms, laboratories and workshops. This very slowly became the dominant interpretation. It is important to recognise that older theories, that of Maxwell, that of Faraday and that of Poynting and J J Thomson continued to live on side by side with the newly emergent theory, but fading slowly. Furthermore, fragments of older theories are still scattered about in odd corners of present-day electromagnetism and have never been incorporated into the new standard theory. Even at the end of the 20th century classical electromagnetism is not entirely finished in an interpretative sense and retains considerable elements of incoherence.

A tentative description of the new standard theory which emerged from the 1920s:

From Lorentz the theory retained the view that charges were primary and sources of the fields, both bound and free fields. The charges maintained the bound fields. Fields were agents of the charges in their actions upon other charges. Stationary charges produced the electric fields and moving charges produced magnetic and electric fields together. Charges and currents transmit the fields at the speed of light. All electromagnetic radiation fields are produced by accelerating charges, which produce both the electric and the magnetic components of these fields together. From Faraday the fields were thought of as pure forces existing in space, not as a material substance or as a process occurring in a material substance. From Lorentz the principle of superposition was adopted according to which fields do not act upon each other. They act only on charges. Lines of force do not repel each other, nor is there any tension along them.

Aspects of Lorentz theory were not adopted into the standard theory. According to Lorentz theory the induced electric field is directly caused by accelerating charges. According to Faraday theory the induced electric field is caused by a changing magnetic field. In the standard theory, therefore, some electric fields are caused by charges and other electric fields are caused by changing magnetic fields. Only as we approach the end of the century is the Lorentz theory beginning to be accepted, according to which all fields are caused by charges and fields do not cause other fields.

Again, in Lorentz theory there is no such thing as a displacement current but in the standard theory Maxwell's displacement current is widely accepted. In Lorentz theory the lines of force are not independent physical entities, they are a mapping of force directions, only. The Faraday theory of independent physical lines of force seems to have survived until the 1960s when it gradually disappeared from physics. Even to-day, however, it can still be found occasionally - in the concept of the catapult field, for example, in elementary physics literature.

What is the relationship between electric and magnetic fields? Are the electric and magnetic fields independent entities or are they closely related? Einstein's analysis has emphasised that they are closely related. Last century André Marie Ampère argued that there is no magnetic field, that there are electrostatic and electrodynamic fields, both electric fields. Special relativity encourages a similar view. For special relativity the magnetic field is a relativistic perturbation of the electrostatic field. Both fields are produced by electric charges. This seems to suggest that the magnetic field is not qualitatively different from the electric field but is only structurally and

behaviourally different. This view has not gained universal acceptance in macroscopic physics. It also seems incompatible with a belief in magnetic poles.

Modern definitions of the field

William Thomson in 1851 defined the magnetic field as follows: Any space at every point of which there is a finite magnetic force is called a field of magnetic force. According to A.F Abbott O Level Physics, 1978, the space surrounding a magnet in which magnetic force is exerted is called a magnetic field. The beauty of these definitions is that they say almost nothing about the nature of the field and are not, therefore, controversial. It is perplexing, however, to identify space itself with the field, rather than stating that there is a field in space. Indeed, some modern authors are more careful and state that at every point of space where there is, or could be, a magnetic force there is a magnetic field. This states where the field is but does not explain our concept of it. There is a remarkable reluctance in physics to state openly what our concept of the field is. It is buried deep within physical intuition.

A tentative description of the working concept of the field actually used by physicists was then offered as follows:

- Fields are transparent.
- Fields pass through one another without mutual interference. They are rather like sound waves and light waves in this respect.
- Fields are not material substances.
- Fields are pure forces or the potentiality for forces in space. They act directly on test charges as agencies of distant source charges.
- They are propagated at the speed of light from source charges.

Bound fields are commonly thought of as hypothetical entities since we cannot observe them directly and arrive at the concept on the basis of inference. The most powerful evidence for their existence is the retardation at the speed of light of the transmission of the bound fields to a test charge or currents.

Radiation fields, on the other hand, are commonly thought of as empirical entities, since we can see light and feel infrared radiation. Summing up, Dr Roche argued that for many physicists the working concept of the electric or magnetic bound field is of a hypothetical nonmaterial force condition which actually exists in space ready to act on any test charge which is placed there. Radiation fields are generally thought of as real. He also pointed out that some physicists think of the bound field as a mathematical artifact.

Future Meetings arranged by this Group

Recollections of early years as a physicist in Poland

Professor Sir Joseph Rotblat, FRS

Monday, 8 March 1999, 18:00 for 18:30
Institute of Physics, 76 Portland Place, London

Joseph Rotblat was born in Warsaw in 1908 and was educated as a physicist, becoming Assistant Director of the Atomic Physics Institute of the Free University of Poland in 1937. Two years later he moved to Liverpool, and then to Los Alamos to work on the Manhattan project. He quit the project and returned to Liverpool in 1944. From 1950 until 1976 he was Professor of Physics at the University of London and at St. Bartholomew's Hospital. He was one of the signatories of the Russell-Einstein Manifesto in 1955. In 1957 he co-founded the Pugwash Conferences, serving as its first Secretary-General until 1973, as President from 1988 to 1997, and remaining active in the organisation ever since. In 1995 he was awarded the Nobel Peace Prize, jointly with the Pugwash Conferences. He is the author of numerous books on nuclear and medical physics, control of nuclear weapons, disarmament, and the Pugwash movement. He is now best known for his work against nuclear weapons, but in this lecture he will go back to the nineteen-thirties and speak about the start of his scientific career in Poland and the start of the nuclear age.

If you wish to attend the lecture, please contact the Honorary Secretary, Neil Brown, by Monday, 1st March:

Post: *C. N. Brown, Honorary Secretary, History of Physics Group*
Science Museum, South Kensington, London, SW7 2DD
Fax: *0171 938 9736*
Phone: *0171 938 8046*
e-mail: *n.brown@physics.org*

Physics and Religion

Saturday, 24th April 1999
Institute of Physics, 76 Portland Place, London

This will be an afternoon meeting, with four or five speakers. Further details will be announced in due course, by post and on the History Group's website. For further information before that, please contact the Chairman, John Roche.

P*ost:* *Dr. John Roche, Chairman, History of Physics Group*
Linacre College, St. Cross Road, OXFORD, OX1 3JA
e-mail: john.roche@linacre.ox.ac.uk

Volta and the invention of the electromechanical battery

Saturday, 23rd October 1999
Oxford

This will be a one-day meeting. Speakers will include Lucio Fregonese on Volta's theory of electrical force; Willem Hackmann on the history of the concept of contact potential; John Roche on the concept of voltage; Neil Brown on the development of batteries through the 19th century; and Paola Bertucci on Galvani. Further details will be announced in due course, by post and on the History Group's website. For further information before that, please contact the Honorary Secretary, Neil Brown:

Post: *C. N. Brown, Honorary Secretary, History of Physics Group*
Science Museum, South Kensington, LONDON SW7 2DD
Fax: *0171 938 9736*
Phone: *0171 938 8046*
e-mail: n.brown@physics.org

Other Lectures and Meetings, at home and abroad

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. All dates are in 1999 except where otherwise stated.

Royal Institution Centre for the History of Science and Technology

As part of the celebrations to mark the bicentenary of the founding of the Royal Institution, all the RICHST Research seminars during the year will deal with topics relating to the history of the Royal Institution and those who worked in it. Further information from Dr. Frank James, Royal Institution, 21 Albemarle Street, London W1X 4BS.

"Theoretical improvements accompanied by practical advantages":
Rumford, Banks, Davy
at Council Room
on 30th March (18:00, with tea from 17:30)
Professor David Knight (Durham University)

Faraday
on 27th April (half day meeting)

British Society for the History of Science

On Time: History, Science, Commemoration
at National Museums and Galleries on Merseyside, Liverpool
on 16th – 19th September
This conference is organised in conjunction with the Royal Historical Society and the National Museums and Galleries on Merseyside. The approach of the Millennium has heightened awareness of the conventions and cultures of time. But what is time? This question has been of growing interest amongst historians. Their research is markedly interdisciplinary, spilling over the boundaries between social, economic and cultural historians, and historians of science, technology, medicine and mathematics. Papers with a wide

interest and historiographical scope are invited. Possible sessions include: Beginnings and Origin Stories, Commemoration, Maritime Time, Timetables and Technology, Workplaces and Time, Lifetimes and Servitude, Units of Time, Immortality. Offers of papers together with abstracts of 50-100 words should be sent before 1st September 1998 to either Dr William J Ashworth, Department of Economic and Social History, The University of Liverpool, 11 Abercromby Square, Liverpool, L69 3BX or Dr Roland Quinault, School of Historical, Philosophical and Contemporary Studies, Faculty of HTE, University of North London, 166-220 Holloway Road, London N7 8DB.

History of Electricity
at the Royal Institution
on 7th April
This meeting which is jointly organised with the Royal Institution Centre of Science and Technology and the History of Technology Group of the Institution of Electrical Engineers will mark the bicentenaries of the invention of the electric battery and the founding of the Royal Institution. Speakers will be David Knight, Frank James, Graeme Gooday, Gerrlynn Roberts, Brian Bowers, Colin Hempstead, Gill Cookson and Albert Moyer. Further details from Dr. Frank James, Royal Institution, 21 Albemarle Street, LONDON W1X 4BS; e-mail: fjames@ri.ac.uk.

American Association for the History of Medicine

Annual Meeting
at Brunswick, New Jersey
on 5th – 9th May
Offers of papers to and further information from Elizabeth Fee, History of Medicine Division, National Library of Medicine, Bldg 38, Room 1E-21, 8600 Rockville Pike, Bethseda, MD 20894, USA

Australian Society of the History of Medicine

6th Biennial Conference
at University of Sydney
on 7th – 10th July
The conference theme will be "Individuals and Institutions in the History of Medicine". Further details from and offers of papers to 6th Biennial

conference of the Australian Society of the History of Medicine Inc c/- ICMS Pty. Ltd., Locked Bag Q4002. QVB Post Office NSW 1230, Sydney, Australia; e-mail: hom@icms.com.au

European Association for the History of Psychiatry

Neurosciences and Psychiatry: Crossing the Boundaries
at Zurich and Lausanne
on 14th – 18th September
Offers of papers on this and relates topics together with a three hundred word abstract should be sent by 30th January 1999 to Dr med Caroline Jagella, Medizinhistorishes Institut der Universität Zürich, Rämistrasse 71, CH-8006 Zürich, Switzerland; e-mail cjagella@mhiz.unizh.ch

German Geophysical Society

History of Geophysics and Space Physics
at Munich
on March 2000
The topic of the meeting will be the development of geophysics over the last few decades. Further information from Dr. Wilfried Schröder, Hechelstrasse 8, D-28777 Bremen-Roennebeck, Germany

International Association of Geomagnetism and Aeronomy

Long- and Short-Term Variability in Sun's History and Global Change
at Birmingham
on July
Topics will include papers from history, archaeology, solar physics, astrophysics among other subjects dealing with historically observed minima in the sun's activities. Offers of papers, by 15th January, to and further details from Dr Wilfried Schröder, Hechelstrasse 8, D-28777 Bremen-Roennebeck, Germany

International History, Philosophy and Science Teaching Group

5th International Conference
at Pavia University
on 15th – 19th September

This conference will bring together scientists, teachers, historians, philosophers, mathematicians and educators. This meeting will also contribute to the local celebrations of the bicentenary of Alessandro Volta's creation of the battery in 1799. Further details from Dr E A Gianetto, Dipartimento di Fisica 'A Volta', Universita di Pavia, via A Bassi 6, 27100 Pavia. Italy; e-mail: volta99@pv.infn.it; www.cilea.it/volta99

John Ray Trust

John Ray and His Successors: The Clergyman as Biologist
at Braintree
on 18th – 21st March
This will be a joint meeting with the Institute of Biology History Committee and the Society for the History of Natural History. The major theme of this conference will centre on the relations of science and religion as exemplified in the life and work of Ray, his contemporaries and successors. Keynote speakers will include John Brooke "Wise men nowadays think otherwise" and Michael Reiss "On being a biologist and a cleric", plus others including Paul Foster, Chris Smith, Sandy Baker, David Knight, Mark Seaward, Edward Larson and Peter Bowler. Bookings and details from Janet Turner, John Ray Trust, Town Hall Centre, Braintree, Essex, CM7 3YG. Tel. 01376 557 776; Fax 01376 344 345

Royal Meteorological Society History Group

London weather through the centuries - part 2
at Science Museum
on 27th March
This meeting will cover meteorology in London in the 19th and 20th centuries; Luke Howard, observations at Greenwich and on the Air Ministry roof. Further details from the Group Secretary, M E Crewe, Royal Meteorological Society, 104 Oxford Road, Reading, RG1 7LL.

Meeting to Celebrate the Society's 150th Anniversary
at the Royal Society
on 3rd – 4th April 2000
This meeting, which is co-sponsored by the Institution of Civil Engineers, Royal Astronomical Society and Royal Geographical Society will cover the history of the Society, its antecedents, its contemporaries - the Scottish Meteorological Society and the British Rainfall Organisation, and the

Societies with whom it shared many interests and members - the Royal Society, Royal Astronomical Society, the Royal Geographical Society and the Institute of Civil Engineers. Themes will include: Formation of the early English meteorological societies, from 1823, the Society's administration, premises, membership and publications, G J Symons and the Meteorological Magazine, the Society's relations with instrument makers, and its exhibitions, the Society's connections with medicine and the natural sciences, with astronomy and upper air, with technology, and with education, the Scottish Meteorological Society, 1855-1921, with Ben Nevis Observatory, English and Scottish Met. Societies' interests in maritime meteorology, British Rainfall Organisation, 1860-1919, and the work of H R Mill, the Society and the Royal Geographical Society, the Society's activities during the past fifty years. Further information will be available later from The History Group Hon Sec, Royal Meteorological Society, 104 Oxford Road, Reading, RG1 7LL.

Society for Hellenic Cartography

18th International Conference On The History of Cartography
at Athens
on 11th – 16th July
This meeting is organised with the National Hellenic Research Foundation, in collaboration with Imago Mundi Ltd. The theme of the conference is "The Cartography of the Mediterranean World". Offers of papers to and further information from Dr. George Tolias, 18th International Conference on the History of Cartography, The National Hellenic Research foundation, 48 Vassileos Konstantinou Avenue, GR-116 35, Athens, Greece; e-mail: gtolias@eie.gr

Society for the History of Natural History

Drawing from Nature: Art and Illustration in the Natural History Sciences
at the Natural History Museum
on 14th – 16th April
This meeting, held jointly with the Natural History Museum will explore the role of illustrations and of illustrators in the construction of natural history. Invited speakers are Martin Kemp, David Freedberg, David Scrase, Nicolas Barker and Andrew Scott. Offers of papers to and further information from Paul Cooper, Zoology Library, Natural History Museum, Cromwell Road, London SW7 5BD; e-mail: p.cooper@nhm.ac.uk

Trinity College, Cambridge

Teaching and Learning in 19th Century Cambridge
at Trinity College, Cambridge
on 8th and 9th April
Topics to be covered include the formal courses of instruction carried out by university officers and college fellows, as well we the coaching system that was so much a part of 19th century Cambridge, especially in mathematics. But also how the curriculum was influenced by religious and secular ideologies, how students learnt to be students through their social contacts, how academic publication influences and responds to student's needs and how issues of gender and class affect the curriculum. Please send offers of papers and suggestions for topics to Jonathan Smith, Trinity College Library, Cambridge, CB2 1TQ

University of Plymouth

ECLIPSE 99: Navigational Stimulus to the History of Science
at University of Plymouth
on 9th – 12th August
This conference, which coincides with the next total eclipse of the Sun to be visible from England, will explore the impact of navigation on the history of science. Offers of papers to and further information from P A H Seymour, Institute of Marine Studies, University of Plymouth, Drake Circus, Plymouth, Devon, PL4 8AA