Historical Group

NEWSLETTER and SUMMARY OF PAPERS

No. 77 Winter 2020

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RSC Historical Group Newsletter No. 77 Winter 2020

Contents

From the Editor

Welcome to the winter 2020 RSC Historical Group Newsletter. The first meeting organised by the group in 2020, "The Handed World: 150 Years of Chiral Molecules", will review optical activity and molecular chirality from a historical perspective. It will take place at the Royal Society of Chemistry, Burlington House, London, on Thursday 19 March 2020. Full details on how to register for the meeting can be found in the flyer enclosed with the hard copy version of the newsletter and in the online version. Registration is also available online via the RSC's meeting booking system.

This issue contains a wide variety of news items, short articles and reports. The first short article is by Mike Jewess and entitled "Chemical Implications of Induced Transmutation". Then Chris Cooksey explores "The Rise and Fall of Meldola Blue". Finally, Jeff Levison provides a personal reflection on the life of the chemist Alfred Bader, who died in late 2018. There are book reviews of the following three publications: Annette Lykknes and Brigitte Van Tiggelen, *Women in their Element: Selected Women's Contributions to the Periodic System;* Gareth Williams, *Unravelling the Double Helix: The Lost Heroes of DNA;* and Peter Wothers, *Antimony, Gold and Jupiter's Wolf: How the Elements were Named*. A short item on the replacement Moseley Chemical Landmark Plaque in Oxford follows. Those who missed the Historical Group's joint meeting with the Society for the History of Alchemy and Chemistry and the Royal Institution can read summaries of the papers given on the chemist and science journalist, William Crookes (1832-1919). There are also reports of the International Conference for the History of Chemistry held in Maastricht, the reception to mark the life of Joseph Priestley in Nantwich and the Dyes in History and Archaeology meeting held in Amsterdam.

I would like to thank everyone who has contributed to this newsletter, particularly the newsletter production team of Bill Griffith and Gerry Moss and also John Nicholson, who liaises with the RSC regarding its online publication. If you would like to contribute items such as news, short articles, book reviews and reports please do contact me. The guidelines for contributors can be found online at http://www.chem.qmul.ac.uk/rschg/Guidelines.html

The deadline for the summer 2020 issue will be Friday 5 June 2020. Please send your contributions to a.simmons@ucl.ac.uk as an attachment in Word. All contributions must be in electronic form. If you have received the newsletter by post and wish to look at the electronic version which includes colour photographs it can be found at http://www.rsc.org/historical or http://www.sbcs.qmul.ac.uk/rschg/

The Historical Group posts the hard copy version of the newsletter to those members who request it. Printing and posting the hard copy version is expensive and if you are receiving the newsletter in hard copy and would be happy to read it online, please send an email to our Membership Secretary, Bill Griffith (w.griffith@ic.ac.uk). Similarly, email Bill if you don't currently receive the hard copy and would like to do so. Group members should receive an email from the RSC informing them when the latest version is available, but for the record the Newsletter appears twice each year – usually in January/February and July/August. It is often available online for several weeks before official notification is sent out by the RSC, so please do look out for the newsletter on both the RSC and Queen Mary Historical Group websites given above.

Anna Simmons
UCL

Letter from the Chair

I am writing to you all to tell you about our new initiative to involve our members more in our activities. It is now the policy of the RSC to interact with its members largely through the interest groups and local sections. It therefore behoves us to take steps to bring the Historical Group closer to its members, especially those who live outside the London area. Our first step was to ensure that all members who wish to hear from us (by email) can do so. It has come to our attention over the last year or so that several members were puzzled why they had not received this newsletter via email. As it almost invariably turned out that they had unwittingly opted out of e-mail communications from the RSC (which includes the Historical Group as our emails are "posted" by the RSC), we decided to contact those members who had opted out of email communications by letter to ask them if they wished to receive emails from us. Of the forty-odd members we contacted, six have asked to be opted into emails, so it has certainly been a worthwhile exercise.

In our second step, we are introducing the informal position of regional representative. These regional representatives will act as a conduit between the committee and Historical Group members in their region, and will offer historical talks by our members to the local section secretaries in their region, using a local list drawn up by them and a national list which will be sent to all regional representatives in due course. If you are interested in becoming one of our regional representatives please contact me by email (or letter). Contact details are provided at the beginning of this newsletter.

As our third step, we wish to involve members more in our meetings. We are very grateful to all the members who come to our meetings to listen to the talks, sometimes travelling long distances, but we would like to give you the opportunity to participate in the meetings. One way of doing this is to give a paper at one of our meetings. There are two calls for papers at present, one for our meeting on the life and work of Sir Geoffrey Wilkinson on 31 March 2021. If you would like to give a paper about Wilkinson or on a topic closely related to Wilkinson, please contact the organiser Henry Rzepa: rzepa@rzepa.net by email. The other meeting on the topic of women in chemistry will be held on 13 October 2021 and if you would like to give a paper at that meeting, please contact the pro temp organiser John Hudson: johnhudson25@hotmail.com by email. I must emphasise that while we are keen to have more of our members giving papers at our meetings, the selection of the papers for any given meeting is made by the organising committee for that meeting and for purely practical reasons, we may not be able to accept all the papers we might be offered.

Finally, we would like to give members the opportunity to suggest topics for future meetings. Currently we have meetings arranged up to October 2021, but we are open to suggestions for meetings in 2022 and 2023. The meetings are usually held at Burlington House, typically in March and October, but if you wish to suggest a different venue and a different date, this might be possible if there is a strong reason for doing so. You can get ideas for possible meetings by looking at the meetings we have held in the past, for example, several of our meetings have been connected to anniversaries. Please send a brief outline of your proposal to our Secretary John Nicholson, whose email address is at the front of this newsletter. We are also considering holding a non-thematic meeting to give members the chance to give papers about their research in the next few years. We have not held such a meeting for many years now and this would give members a chance to talk about topics dear to their hearts. I have gone on long enough now and it only remains for me to wish you all the very best for 2020.

Peter Morris

ROYAL SOCIETY OF CHEMISTRY HISTORICAL GROUP MEETINGS

The Handed World: 150 Years of Chiral Molecules

Thursday 19 March 2020, Royal Society of Chemistry Burlington House, Piccadilly, London

The meeting will review optical activity and molecular chirality from a historical perspective – beginning in the nineteenth century and ending with techniques that are used today in the latest facilities such as the Diamond Light Source, with special reference to the biological and pharmaceutical importance of chirality.

Programme

10.15 Registration and tea or coffee

10.45 Welcome - Dr Peter Morris (Historical Group, Chair)

First Session: Introduction: The Science to about 1890, with Postscripts

Chair: Dr John Hudson (Historical Group Committee)

10.49 *Introduction to the Day*

Dr Michael Jewess (Historical Group Committee)

10.55 *Discovery of the Phenomenon of Polarisation of Light*

Prof. John Steeds, FRS (University of Bristol)

11.35 *Discovery of Optical Activity and Chirality in Molecules*

Prof. Alan Dronsfield (University of Derby)

12.30 Lunch: this is not provided but there are many cafés and bars close by.

Second Session: The Science from about 1890

Chair: Dr Michael Jewess

14.00 *From d and l to R and S: Discovery of Absolute Configuration*

Prof. Henry Rzepa (Imperial College)

14.30 *Polarised Light and Chemistry Today*

Dr Giuliano Siligardi (Diamond Light Source)

15.15 Tea interval

Third Session: Chirality and Pharmaceuticals in Recent Decades; Conclusion

Chair: Dr Viviane Quirke (Oxford Brookes University)

15.45 *Does the Right Hand Know what the Left Hand is Doing? – Chirality in Real Life*

Dr Ian Blagbrough (University of Bath)

16.55 Concluding remarks - Dr Michael Jewess

17.00 Close of meeting

Fuller details are available at http://www.rsc.org/events/detail/40046/the-handed-world-150-years-of-chiral-molecules.

REGISTRATION

There is no charge for this meeting, but prior registration is essential. Please use the "BOOK NOW" button at http://www.rsc.org/events/detail/40046/the-handed-world-150-years-of-chiral-molecules, or e-mail michaeljewess@researchinip.com, or write to Dr Michael Jewess, The Long Barn, Townsend, Harwell, Oxon OX11 0DX. As usual, this is expected to be a popular meeting, so if, having registered, you are unable to attend, please cancel through the link provided in the confirmation e-mail (if you have used the "BOOK NOW" button) or by notifying Dr Jewess.

ROYAL SOCIETY OF CHEMISTRY HISTORICAL GROUP NEWS

Secretary's Annual Report for 2019

One of my duties as Secretary is to provide a brief annual report on our activities to the RSC. The following is the basis of my brief report, so that as members of the Group, you can get an overview of what we have been doing.

On 14 March 2019 we held a one-day meeting at Burlington House, London, on the History of IUPAC. This was organised by Gerry Moss and covered the emergence of international cooperation in chemistry dating back to the famous Karlsruhe Conference in 1860, and coming right up to date with the current, very varied work of IUPAC.

Our next meeting was a joint one with the Institute of Physics (IOP) History of Physics Group, held in Manchester on 8 June 2019. It was led by the IOP and on the subject of Transmutation. It was held to mark the centenary of the publication of the famous paper "Collision of a-particles with light atoms: I, II, III, IV" by Ernest Rutherford, in which he reported results of colliding alpha particles with nitrogen atoms. Although there is doubt that he recognised its significance, this is widely acknowledged as the discovery of artificial mutation. The day included several talks and also a tour of the old laboratories where Rutherford carried out the work.

Then, on 19 October, we held a join meeting with the Society for the History of Alchemy and Chemistry at the Royal Institution, London, organised by Frank James on the life and work of Sir William Crookes. Accounts of the papers given at this meeting appear elsewhere in the Newsletter. As usual, it was a well-attended meeting and attracted much interest from all those who could be there.

Lastly, I am happy to report that we published two editions of the Group Newsletter during the year. These are very high standard publications, to which the term "newsletter" does less than justice. Thanks go to Anna Simmons, who as editor does an excellent job of persuading or cajoling a large number of individuals to contribute, and making it the high-quality publication that we all enjoy.

John Nicholson

Follow-up from the Summer 2019 *RSC Historical Group Newsletter*

The Periodic Table Upside-down.

In the Summer 2019 *Newsletter* I published a Short Essay on "How the Group VIII Elements Posed a Problem for Mendeleev". In August this year, after the essay had been submitted, a remarkable paper appeared in *Nature* by Sir Martyn Poliakoff (M. Poliakoff, A.D.J. Makin, S.L.Y. Tang and E. Poliakoff, *Nature Chem*. 2019, 11, 391-3; http://doi.org/ggb8mc). This proposed that rotating the periodic table by 180° about a horizontal axis, placing the light elements at the bottom and the heavy ones at the top, could stimulate the teaching and understanding of periodicity. The paper led to widespread national (e.g. in the *Times*, the *Independent* and *Chemistry World*) and international comment, and would have been an ideal reference to have added to the final section "The Modern Periodic Table" in my essay. I think that Mendeleev would have approved!

Bill Griffith

MEMBERS' PUBLICATIONS

If you would like to contribute anything to this section, please send details of your historical publications to the editor. Anything from the title details to a fuller summary is most welcome.

Clare E. Wilkes, *Framed by a Smoking Gun: The Explosive Life of Colonel B.D. Shaw* (Kibworth: The Book Guild, 2019), Paperback, £9.99, ISBN: 978-1-912575-47-3.

Generations of chemistry students were captivated by B.D. Shaw's maverick and humorous approach to chemistry lecturing. He found fame on BBC Two's Horizon and continued to demonstrate explosives worldwide until the age of ninety-two. His story is a celebration of his joint passions for chemistry and rifle shooting and his devotion to explaining the science of explosives to the world. A review of this book will appear in the summer 2020 *RSC Historical Group Newsletter*.

PUBLICATIONS OF INTEREST

Pere Grapi, *Inspiring Air: A History of Air-Related Science* (Delaware: Vernon Press, 2019), Paperback, 50 Euros, ISBN: 978-1-62273-614-0.

Eudiometers were instruments originally devised for checking the 'goodness' of common air. Seeking to be more than just a chronological inventory of eudiometers, this book presents a unique retrospective of these fascinating apparatuses from the end of the eighteenth century to the mid-nineteenth century. By paying particular attention to the experimental procedures involved over the course of the test, this book aims to understand and explore how eudiometers function, to describe the materials used in making them and the different reagents employed in each eudiometrical test. Importantly, eudiometers were employed within a variety of spheres including human and animal health, gas analysis, chemical theory, plant and animal physiology, atmospheric composition, chemical compound composition, gas lighting, chemical revolution and experimental demonstration. Finally, this book looks to redress the existing imbalance in the history of chemistry regarding the attention given to theoretical aspects of chemistry in comparison to chemical practice and apparatus.

Elena Baum and Tatiana Bogatova, *The Public Status of Russian Chemistry. The Russian Chemical Society: The History and Tradition* (Moscow: Moscow State University, 2019), 30 Euros, ISBN: 978-5-8037-0769-1.

Founded in 1868 and 1869 respectively the Russian Chemical Society (RKhO, since 1878 the Russian Physical-Chemical Society RFKhO) and its journal played a fundamental role in the development of Russian chemistry and the strengthening of its social status. In this anniversary edition devoted to the activities of the Russian Chemical Society various aspects of its role are considered before reorganization into the D.I. Mendeleev All-Union Chemical Society. The introduction outlines the general picture of the creation of professional chemical societies in Europe in the nineteenth century and presents an attempt understand the place of the RKhO and RFKhO amongst them.

The following journal issues have been published since the summer 2019 *Newsletter* was completed.

Ambix: The Journal of the Society for the History of Alchemy and Chemistry

Ambix, vol. **66**, issue 4, November 2019

Alan J. Rocke, "Lothar Meyer's Pathway to Periodicity".

Frank A.J.L. James, "Humphry Davy's Early Chemical Knowledge, Theory and Experiments: An Edition of his 1798 Manuscript 'An Essay on Heat and the Combinations of Light' from the Royal Institution of Cornwall, Courtney Library, MS DVY/2".

William H. Brock, "A German Partington". Essay review of Jost Weyer's *Geschichte der Chemie. Band I – Altertum, Mittelalter, 16. bis 18. Jahrhundert. Band II – 19. und 20. Jahrhundert.*

Bulletin for the History of Chemistry

Bulletin for the History of Chemistry, vol. **43**, number 2, 2018

Jeffrey I. Seeman, "*Profiles, Pathways and Dreams*: From Naïveté to the Hist Award".

G.J. Leigh and Carmen J. Giunta, "The Scientific Publications of Alexander Marcet".

Joäo Paulo André, "Frederick Accum: An Important Nineteenth-Century Chemist fallen into Oblivion".

C.H. Delegard, V.F. Peretrukhin and S.I. Rovny, "The Contributions of Radiochemistry to Mastering Atomic Energy for Weapons".

Jessica Epstein, "Drugs that shaped the FDA: From Elixir Sulfanilamide to Thalidomide".

M.R.V. Sahyun, "Melville Sahyun: A Life in Biochemistry".

Eric R. Scerri, "Response to review of *A Tale of Seven Scientists*".

Book Review

E. Thomas Strom and Vera V. Mainz (eds.), *The Foundations of Physical Organic Chemistry: Fifty Years of the James Flack Norris Award*. Reviewed by Joseph B. Lambert.

Bulletin for the History of Chemistry, vol. **44**, number 1, 2019

Julianna Poole-Sawyer, "A Changing Curriculum: Pharmacological Texts at the University of Paris in the Twelfth and Thirteenth Centuries".

Mary Ellen Bowden and Dee Ann Castel, "Note: A Modern Scientific Interpretation of Joseph Priestley's Discovery of CO".

Carmen J. Giunta, "A Survey of History of Chemistry by Chemists".

Nenad Raos, "Oparin's Theory of Biogenesis: Biocolloidal or Biomolecular?"

Kaspar F. Burri and Richard J. Friary "A School for Synthesis: R.B. Woodward and the Woodward Research Institute Remembered".

Thomas A. Perfetti, "The Recipients of the Dexter and Sidney M. Edelstein Awards: Biographies of Men and Women of the History of Chemistry, An Enjoyable Journey Through Chemistry".

Jeffrey I. Seeman, "The Back Story".

Book Reviews

E. Thomas Strom and Vera V. Mainz (eds.), *The Posthumous Nobel Prize in Chemistry. Volume 1*. Reviewed by Arthur Greenberg

Reinhard W. Hoffmann, *Classical Methods in Structure Elucidation of Natural Products*. Reviewed by Jeffrey I. Seeman.

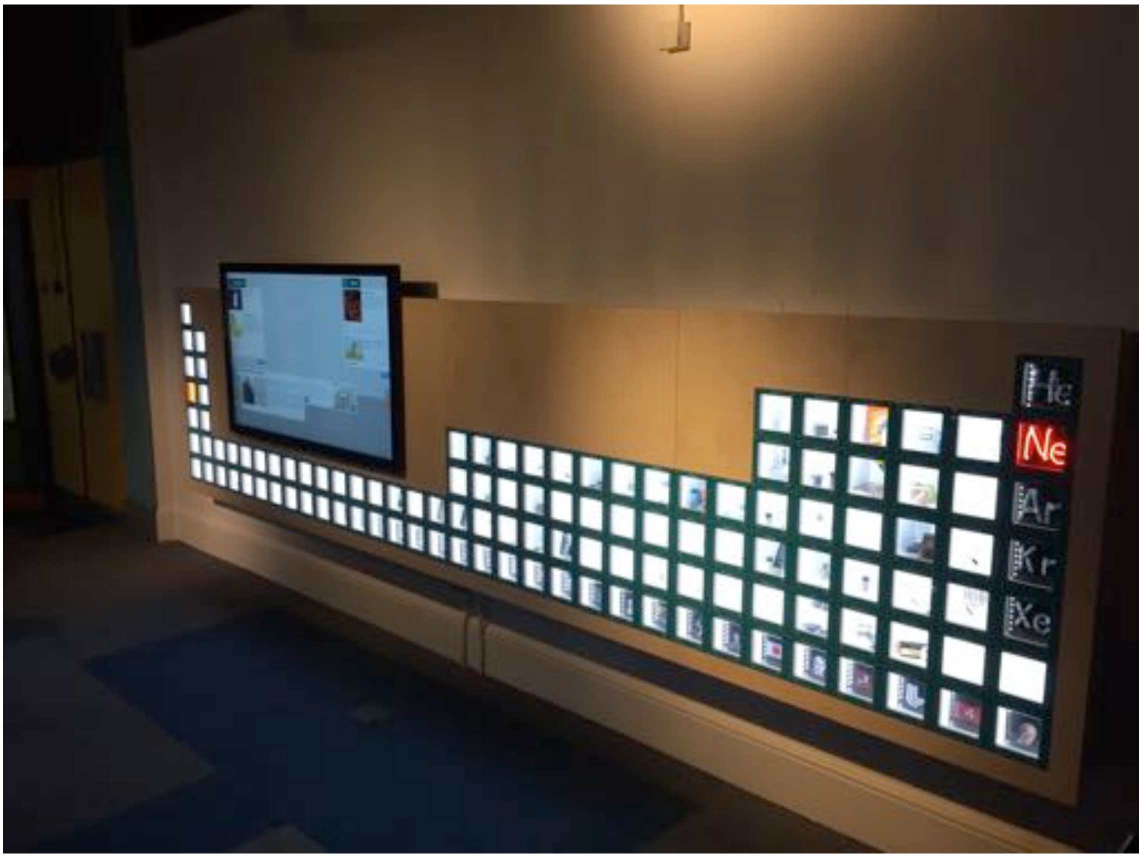
NEWS AND UPDATES

News from Catalyst: Launch of Interactive Periodic Table Exhibit at Catalyst, 22 October 2019

The Catalyst Science Discovery Centre at Widnes has been successful in its bid for funding from the Wellcome Trust and UK Research and Innovation to transform some of the areas within the building, and also to expand its work with visiting groups. As part of this project the ground floor gallery is being refurbished and will be provided with new exhibits. This event was held to launch the first exhibit to be installed in the new gallery - an interactive periodic table. It was constructed with the aid of a grant from the RSC with additional funding from the CICAG Interest Group, and forms part of the RSC's contribution to the International Year of the Periodic Table.

One wall of the gallery has been made into a giant periodic table. Each element is provided with an illuminated glass fronted box, recessed into the wall. Each box contains objects relevant to the element in question – a sample of the element where possible, and/or samples of important compounds, etc. For unstable or dangerous elements a relevant image is provided. Alongside is a giant touch screen. When the name of an element is tapped, the illumination of the corresponding box in the table changes to orange, and information about the element is displayed on the screen. The information that appears will be changed by Catalyst staff, so that it is always relevant and up to date. For example, when lithium was tapped, a few sentences appeared conveying the information that the previous week the 2019 Nobel Prize for Chemistry had been awarded to John Goodenough, Stanley Whittingham and Akira Yoshino for their work developing lithium-ion batteries. Thus, the exhibit is interactive in the sense that the user can learn interesting details about any element or elements of their choice, and the information will be continually updated, making the exhibit future-proof.

The launch was attended by around seventy people, including patrons and supporters of Catalyst, representatives of local organisations and the RSC, and parties of schoolchildren and their teachers. The proceedings commenced with addresses from Martin Pearson, Chief Executive of Catalyst, and Diana Leitch, Chair of Trustees. David Phillips, previous President of the RSC, then gave a speech in which he revealed he had spent a post-doctoral year in the former USSR, and he described how proud the Russians were that the periodic table had been the work of one of their number. He then cut a ribbon which had been placed across the touch screen and declared the exhibit open.



The Giant Periodic Table at Catalyst

By Spring 2020 the refurbished gallery will be completed with the installation of a further twenty-four new exhibits. These, along with the interactive periodic table, will enable Catalyst to expand further its provision for visitors and groups in the local community. As David Phillips said "Catalyst is an inspiration.... It demonstrates the utility of chemistry for the world and it is in the site where so much of the chemical industry was founded and still continues today. It is a very, very special place".

John Hudson

Division of History of the American Chemical Society: Presentation of the 2019 HIST Award in San Diego, August 2019

One-time University College London (UCL) undergraduate (1942-44) and postgraduate (1944-46) Otto Theodor ("Ted") Benfey received the 2019 HIST Award for Outstanding Achievement in the History of Chemistry by the Historical Division of the American Chemical Society at its meeting in San Diego in August 2019. Ted made his undergraduate studies in Aberystwyth when the UCL chemistry department was evacuated to Wales; he then studied solvent effects on Sn1 mechanisms for his PhD with Christopher Ingold before post-doc studies with Louis Hammett at Columbia University in 1947. Benfey, a German Jewish child refugee in 1936 when he was ten years of age, became a lifelong pacifist. He never returned to the UK, but instead taught organic chemistry in a number of American Quaker colleges before becoming editor of the ACS's High School magazine *Chemistry* in 1964. While teaching chemistry at Earlham College (1955-64) he became closely involved in the Chemical Bond curriculum project (1957-64) that mirrored the Nuffield teaching project in the UK. He also became well-known to historians of chemistry for the outstandingly-useful and meticulously-edited source book, *Classics of the Theory of Chemical Combination* (Dover: New York, 1965) and its later companion text, *From Vital Force to Structural Formulas* (ACS: Washington, 1975), many papers and translations on the history of chemistry, and his co-editorship with Peter Morris of *Robert Burns Woodward, Architect and Artist in the World of Molecules* (CHF: Philadelphia, 2001). He has an extensive *Wikipedia* entry and lives in retirement at a Quaker refuge at Guilford, Connecticut.

Unfortunately, Ted was unable to be physically present at the meeting when, under the affable chairmanship of chemist historian Jeff Seeman, he was honoured by a day of papers devoted to his work. Among the speakers were his former Earlham College pupils, the organic chemist Larry E. Overman and the Newton alchemical scholar, William R. Newman, both of whom reflected on Ted's influence on their chosen careers; Mary Virginia Orna who explained why High School teachers were so excited by Ted's editorials in *Chemistry* magazine; Ned D. Heindel reminisced about Ted's "retirement" career in the earliest days of the Chemical Heritage Foundation (1988-96) when he produced the *Chemical Heritage* magazine; Alan J. Rocke described Ted's inspired invention of the spiral ("snail") form of the periodic table (1964) and extolled the continuing value of his two *DSB* articles on Archibald Scott-Couper and Lothar Meyer; Robert Anderson linked Ted's role as a German refugee with that of Prince Albert; and W.H. Brock connected Ted's 1966 doctoral thesis on solvent salt effects and his work in changing the American chemistry High School curriculum with the activities of Henry Edward Armstrong while teaching at the Central City and Guilds College between 1885 and 1912. Finally, James Fernandes of Guilford College explained how Ted's Quaker legacy and influence still continue at the Friends' colleges where he taught. Events were suitably concluded by a dinner in a Mexican restaurant where Ted's outstanding career was toasted.

William Brock

David Knight Memorial Page

The Department of Philosophy at Durham University has set up a memorial page for David Knight. It features a brief biography and a list of his works and includes the obituary written by Matthew Eddy and published in the *RSCHG Newsletter*, winter 2019, **75**, 8-15,

https://www.dur.ac.uk/philosophy/research/

Zeitkolorit - Mode und Chemie im Farbenrausch (1850-1930)

Deutsches Textilmuseum Krefeld, Germany, 29 September 2019 to 29 March 2020

The exhibition deals with the invention of synthetic dyestuffs and its impact on fashion. Up to fifty garments from the museum's collection from the 1850s to the 1930s demonstrate the evolution of fashion during that time, whilst also focusing on colour, dyes and the history of dye chemistry. These garments are displayed together with about 250 bottles containing the original dyestuffs (including a bottle of mauveine from the Dresden collection). The exhibition also contains natural dyestuffs, sample-books on current textile dyeing experiments, chemical instruments and recipe-books. This exhibition is one of the results of the three-year research project "Weltbunt" that worked on identifying and analysing 10,600 bottles of dyestuffs provided by the chemical industry to the former Krefeld Gewebeschule mainly in the 1880s.

SHORT ESSAYS

Chemical Implications of Induced Transmutation

Background

In 1901, Ernest Rutherford and Frederick Soddy became aware that spontaneous transmutation of elements was occurring in the natural radioactive decay series (of uranium and thorium), and Rutherford reportedly said to Soddy: "For Mike's sake, Soddy, don't call it transmutation. They'll have our heads off as alchemists" [1]. In 1919, Rutherford achieved the first induced or artificial (i.e. non-spontaneous) nuclear transmutation, and in December 1934, Rutherford was able justifiably to assert his own part in realising "the old dream of the alchemists" [2]. 1934 was also the year in which the first induced transmutation of direct interest to chemists was achieved (see next Section).

Before 1934, reactions such as the following had been performed:

$$^{4}_{2}\mathrm{He} + ^{14}_{7}\mathrm{N} \rightarrow ^{17}_{8}\mathrm{O} + ^{1}_{1}\mathrm{H} \qquad \text{(eq. 1)}$$

(Rutherford's reaction of 1919 [3] as later elucidated by P.M.S Blackett [4], in which alpha particles were used to bombard nitrogen nuclei); and

$$^{7}_{3}\mathrm{Li} + ^{1}_{1}\mathrm{H} \rightarrow \mathbf{2}\,^{4}_{2}\mathrm{He} \qquad \text{(eq. 2)}$$

(Cockcroft and Walton's "splitting of the atom" experiment [5], using electrostatically accelerated protons and involving a loss of rest mass exceeding 0.2 % and therefore a serious energy release according to $E = mc^2$).

For all their fundamental importance to physics, these reactions were of little direct (synthetic) interest to chemists, merely producing naturally occurring non-radioactive nuclides in tiny quantity.

Induced Transmutation Releases the Potential of the "Tracer"/"Label" Technique

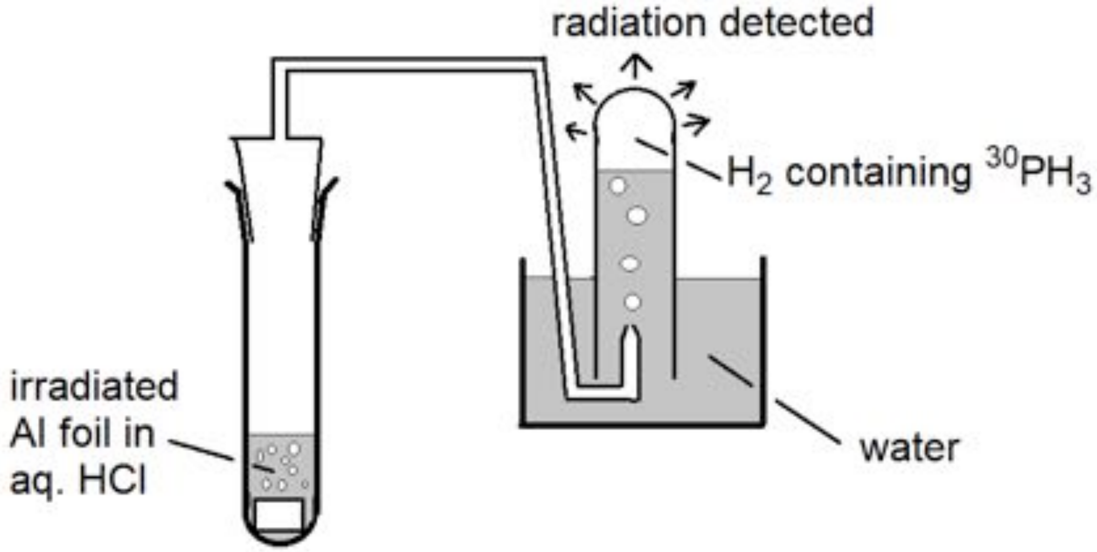
In 1934, Joliot and Joliot-Curie effected the first transmutation in which a previously unknown and intensely radioactive nuclide, ^{30}P, was produced:

$$^{4}_{2}He + ^{27}_{13}Al \rightarrow ^{30}_{15}P + ^{1}_{0}n \quad \text{(eq. 3)}$$

(see first Box) [6, 7]. By the end of 1935, radionuclides of other elements of low atomic number had been discovered, using both bombardment with charged particles and also bombardment with neutrons. (A neutron has the advantage that it is not electrostatically repelled by the target nucleus, which commonly captures it so that its mass number is raised by 1.)

Joliot and Joliot-Curie's Astonishingly Simple Chemistry with ^{30}P

The key product in eq. 3, ^{30}P, has a half-life of 2.5 minutes, undergoing decay by positron emission, with which transient species Joliot and Joliot-Curie did some simple chemistry using apparatus reminiscent of beginning secondary school chemistry.



The irradiated Al target was removed from the irradiation apparatus before too much of the ^{30}P had decayed and was reacted with hydrochloric acid. The Al dissolved producing H_2, which was collected over water in an inverted tube. Nascent hydrogen on the target surface reduced the ^{30}P to give $^{30}PH_3$, which passed over with the H_2. The collection tube was very thin-walled, so that Joliot and Joliot-Curie could detect the radioactivity of the collected gas. Had the phosphorus isotope generated *not* been radioactive, the tiny amounts would have been undetectable.

Joliot and Joliot-Curie were practising (in Joliot's words) –

"[a] special kind of chemistry in which one handles unweighable quantities, sometimes of the order of 10^{-16} g, made possible [because] one can determine and follow by measuring the radiation emitted, infinitesimal traces of radioactive matter dispersed in the midst of other matter."

Previously to 1934-1935, intense radioactivity had been exclusively a feature of uranium and thorium natural decay products, all isotopes of elements with atomic numbers ≥ 81 (thallium and beyond). The radioactive "tracer"/"label" technique – which had been proven by Hevesy and Paneth in relation to lead chemistry (see second Box) [8] – could now be applied to the broad range of elements of academic, industrial, and medical interest with atomic numbers < 81. In particular, organic chemistry and biochemistry are dominated by H, C, N, O, Na, Mg, P, S, Cl, K, and Ca, with atomic numbers ranging from 1 to 20.

The fact that only relatively small amounts of light radionuclides could be made with the technology of the 1930s was not a fundamental problem, more one of cost and availability; intrinsic to the "tracer"/"label" technique was the fact that amounts of a substance that could scarcely be weighed could nevertheless be detected if it was sufficiently radioactive, and indeed Hevesy was awarded the 1943 Nobel Prize for Chemistry in deferred recognition of the technique's significance.

Hevesy and the "Tracer"/"Label" Technique

Hevesy's inspiration for the "tracer"/"label" technique was a "depressing situation". In 1911, Rutherford had asked him to separate by chemical means so-called Ra-D from a mixture that mostly consisted of non-radioactive lead, and Hevesy utterly failed, finally understanding that Ra-D had to be a radioactive isotope of lead (in fact ^{210}Pb, half-life 19 years) with chemistry virtually identical to that of the naturally occurring non-radioactive isotopes of atomic mass numbers 204 and 206-8. Another lead isotope, even more active, was Th-B (^{212}Pb, half-life 10.6 hours).

Hevesy realised that by using such isotopes, one could do things in lead chemistry that would be very difficult otherwise. The first step was to "label" a sample of a non-radioactive lead compound with a little of the same compound containing a highly radioactive lead isotope. The chemistry of the isotopes are virtually identical, so that if one performs some chemical operations with the sample then one can tell where the lead as a whole has gone to by tracking or tracing where the radioactivity has gone to. Even if only a very small amount of total lead has departed the sample, one can track it provided the labelling was with a radioisotope of sufficient activity. Hevesy exemplified the necessary calculation as follows:

"Suppose that we dissolve 1 g of [naturally-isotopic $Pb(NO_3)_2$] in water, add [$Pb(NO_3)_2$ with radioactive Pb] of negligible weight showing a radioactivity of one million [units], and proceed to carry out the most intricate operations with this "labelled" lead. If we then [find] one radioactive unit in a fraction obtained in the course of these operations, we must conclude that [1 μg] of the lead atoms present in the [naturally-isotopic $Pb(NO_3)_2$] we started from ... are present in the fraction."

Hevesy's first demonstration of the technique, with Paneth in 1913, related to lead chromate, $PbCrO_4$. By everyday chemical standards, lead chromate is insoluble in water, though thermodynamics requires everything to be soluble to some degree, however small. Hevesy and Paneth made radioactively labelled lead chromate, and found that the tiny amount of the lead chromate that dissolves in water was detectable by its radioactivity. The solubility was determined as 65 microgram per litre, i.e. less than one part in 10^7 by mass.

The "tracer"/"label" technique became commonplace after World War II when ^{235}U nuclear fission reactors produced radionuclides of light elements very cheaply. The neutron flux in reactors was used to produce (fissile) ^{239}Pu from ^{238}U for nuclear weapons [9], and also for transmutation reactions of civil interest. The public feared nuclear energy after observing its appalling effects in Japan; to counter this, governments encouraged and publicised peaceful use of radionuclides from their reactors such as the Oak Ridge National Laboratory of the US Atomic Energy Commission [10]. Radioactive ^{14}C for scientists was about 10,000 times cheaper than previously [11].

^{14}C from Oak Ridge was used to investigate photosynthesis by Calvin and Benson, beginning in the late 1940s [12]. They were seeking to discover the "chemical pathway" of photosynthesis, i.e. the sequence of reactions by which atmospheric carbon dioxide is captured usefully by plants. Algae doing photosynthesis were exposed to carbon dioxide including a small proportion of radioactive $^{14}CO_2$. Calvin and Benson killed the algae with boiling ethanol after various time periods, arresting the photosynthesis at various stages. At each stage, they identified which compounds the ^{14}C had gone into – and by implication where all the C in the carbon dioxide had gone. Paper chromatography was used to separate the various compounds as distinct spots on the paper. Ingeniously simple, they did a photographic contact print of the paper onto X-ray film, thereby locating those spots which contained compounds involved in the chemical pathway. They cut out the relevant bits of the paper and identified the compounds by conventional chemical analysis. By 1958, the key reactions involved had been identified in the form of the Calvin-Benson cycle. Calvin was awarded the Nobel Prize for Chemistry in 1961.

The "tracer"/"label" technique was cheap enough to use in relatively routine analytical investigations analogous to Hevesy and Paneth's determination of the low solubility of lead chromate (second Box). Examples are the determination, using ^{32}P labelling, of the (low) solubility in aqueous media of the principal component of kidney stones resulting from urine infections, struvite, $MgNH_4PO_4.6H_2O$ [13], or the tiny losses of Pt from the exhaust from the catalytic convertor in a car using radioactive Pt [14].

Likewise, the technique was used routinely in the determination of organic reaction mechanisms [15]. A particular carbon atom in molecules of starting material could be labelled with ^{14}C; after the starting material had reacted, the location of the labelling in the product molecules was determined, if necessary, by suitably designed degradation reactions.

However, the use of radionuclides for the purposes described above in this Section has diminished since the 1990s in favour of safer techniques not requiring troublesome radioactive handling [16]. For determination of trace quantities, quite different techniques are now available. For investigation of chemical pathways or reaction mechanisms, it is possible to use naturally occurring stable isotopes, the technology of separating which has improved. For instance, non-radioactive ^{13}C (natural abundance 1.1 %) is now economically separated from natural carbon. 99 % isotopically pure sodium bicarbonate $NaH^{13}CO_3$ can be bought for under £ 60/g [17]. Being cheap, ^{13}C can be used as a label in sufficiently large quantities that, although not radioactive, it can readily be traced by mass spectrometry or NMR.

How Transmutation filled out the Periodic Table

Fig. 1 shows a periodic table of the elements in its commonest modern layout but including only the elements known in 1919, i.e. at the date of Rutherford's bombardment of ^{14}N with alpha particles. The ordering is by atomic number, equal of course to the number of electrons surrounding the nucleus in the uncharged atom. The arrangement, in 18 vertical columns (groups), is by the ground state electronic structures of the uncharged atoms, a few irregularities being ignored.

The table is a useful, approximate (and iconic) systematisation of a vast amount of information – including chemical information since the oxidation states of elements depend on electronic structure [18].

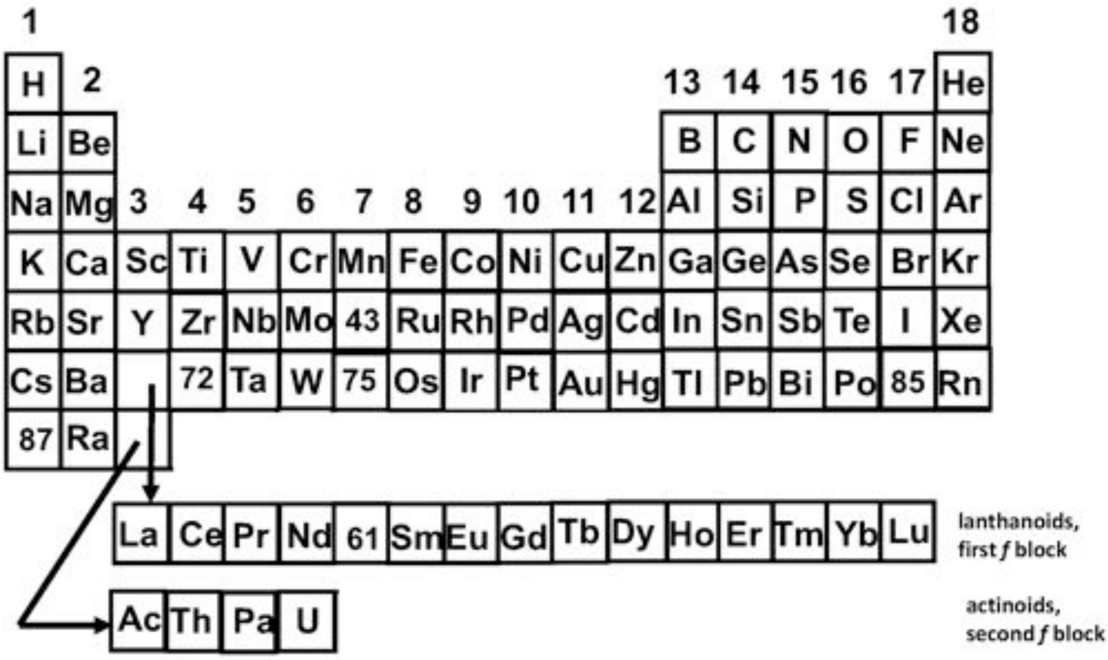


Fig. 1: Periodic Table in "medium-long" layout currently recommended by the International Union for Pure and Applied Chemistry, IUPAC, but showing only elements known in 1919, with then-"missing" elements indicated by their atomic numbers. The group numbers 1 to 18 replace previous numbering systems. The terms "lanthanoid" and "actinoid" replace earlier terms "lanthanide" and "actinide".

The periodic table, had it not been for induced transmutation, would have gathered few further elements: in 1923 and 1925, elements 72 and 75 (Hf and Re) were discovered in minerals; and in 1939 element 87 (Fr) became the last element to be first discovered in a natural radioactive decay series. All other missing elements were first discovered by means of induced transmutation. The first such element was 43 (Tc) discovered in 1937 by Perrier and Segré using accelerated deuterons [19]:

$$^{96}_{42}\mathrm{Mo} + ^{2}_{1}\mathrm{H} \rightarrow ^{97}_{43}\mathrm{Tc} + ^{1}_{0}\mathrm{n} \qquad \text{(eq. 4)}$$

In 1940, the first trans-uranic elements 93 and 94 followed (Np and Pu); for this and subsequent work Edwin M. McMillan and Glenn T. Seaborg jointly received the 1951 Nobel Prize for Chemistry. By 1952, all transuranic elements having isotopes with half-lives exceeding one year had been discovered (i.e. up to actinoid element 99, Es), as well as the last two missing lighter elements 61 and 85 (Pm and At). Elements beyond Es up to the end of the fourth long row were discovered in subsequent decades, some only as isotopes with very short half-lives indeed. The end result is shown in Fig. 2 [20].

The lanthanoids are all crammed into a single box in the third row of group 3 because, as the 4*f* orbitals are filled from La ([Xe]$4f^0 5d^1 6s^2$) to Lu ([Xe]$4f^{14} 5d^1 6s^2$) [21], the *f* electrons tend, energetically, to "disappear into the core" so as not to be available for chemical bonding. As a result, their chemistry is dominated by the +3 oxidation state like that of Sc and Y, though in some lanthanoid compounds the +2 or +4 state occurs. Thereafter, Hf ([Xe]$4f^{14} 5d^2 6s^2$), Ta ([Xe]$4f^{14} 5d^3 6s^2$), W ([Xe]$4f^{14} 5d^4 6s^2$), and Re ([Xe]$4f^{14} 5d^1 6s^2$ resume the normal periodic trend with highest oxidation states of +4, +5, +6, and +7 respectively, matching the elements of groups 4, 5, 6, and 7 in the first two long rows; in Hf to Re, it is the 5*d* and 6*s* electrons that engage in chemical bonding.

The second, actinoid *f* block is analogous to the first in that the 5*f* orbitals are empty in Ac and full in Lr (as are the 4*f* electrons in La and Lu respectively). However, the ground state electronic structures do not always correspond precisely [22]. And, chemically, Th, Pa, and U have highest oxidation states of +4, +5, and +6 respectively, better resembling Hf, Ta, and W than the corresponding lanthanoids Ce, Pr, and Nd. For instance, U has a very stable +6 oxidation state in aqueous solution, like W, whereas the highest oxidation state of Nd in aqueous solution is +4 and even this is unstable (Nd^{4+} ions react with water to produce oxygen gas and stable Nd^{3+} ions) [23]. Only Am–Lr closely resemble the corresponding lanthanoids.

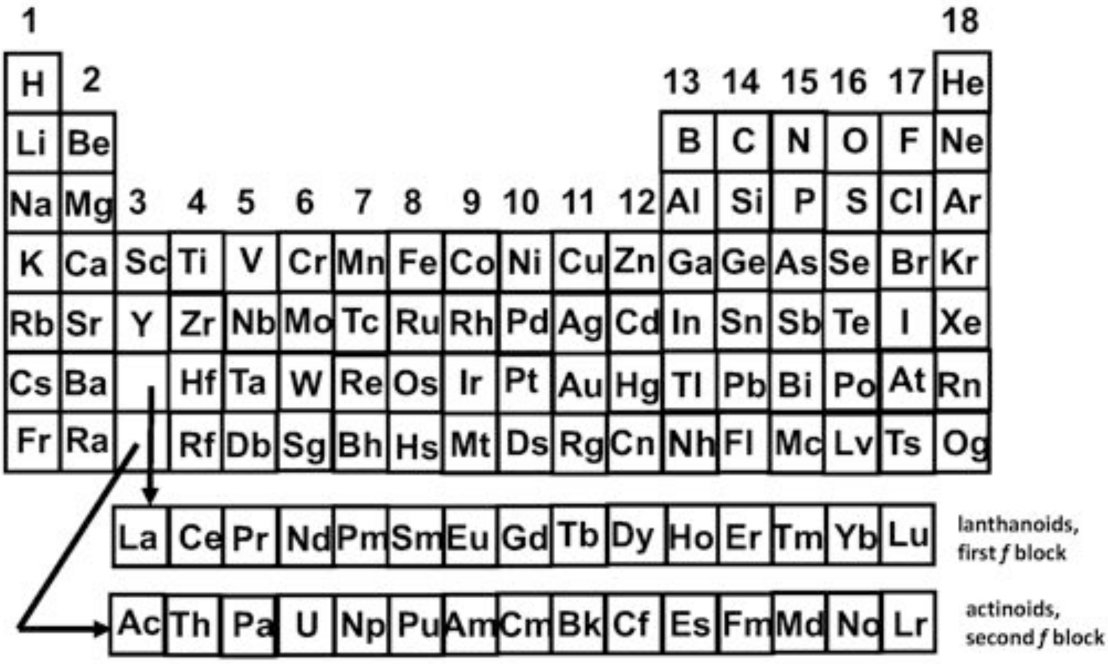


Fig. 2: Periodic Table with elements acknowledged by IUPAC, 1 December 2018.

Therefore, before the transuranic elements were discovered from 1940 onwards, Ac, Th, Pa, and U were *not* shown as in Figs. 1 and 2, but were spread across groups 3 to 6 of the fourth long row, i.e. with Ac on its own in the group 3 box and with Th, Pa, and U in the boxes now occupied by Rf, Db, and Sg in Fig. 2 [24]. The modern arrangement, proposed in essence by the trans-uranic discoverer Seaborg himself [25], is a compromise in favour of the later actinoids and the elements from Rf onwards, at the expense of the earlier actinoids. As noted previously, the periodic table is – and can only be – an approximate systematisation.

Radionuclides from Induced Transmutation in Medicine

An important product of reactors such as Oak Ridge after the Second World War was ^{60}Co for external beam therapy of cancer with 1.17 and 1.33 MeV gamma rays (the use of which has been superseded by accelerators capable of delivering X-ray photons of even higher energies).

Nowadays, the principal medical use of radionuclides manufactured by induced transmutation is in *gamma ray imaging*. The radionuclide is administered to the patient and gamma radiation is detected externally to create an image. Thus, ^{99m}Tc, whose nuclei decay from the excited state to ^{99}Tc emitting 0.14 MeV gamma ray photons, is used to scan hearts for damage after heart attacks [26]. To do this, it must be incorporated in a compound that is readily taken up by heart muscle. Such a compound, trade mark "Myoview", was invented in the late 1980s at the British company Amersham International, now GE Healthcare, with cumulative sales exceeding £1.3 bn by 2007 [27]. The active species is the singly charged cation shown in Fig. 3.

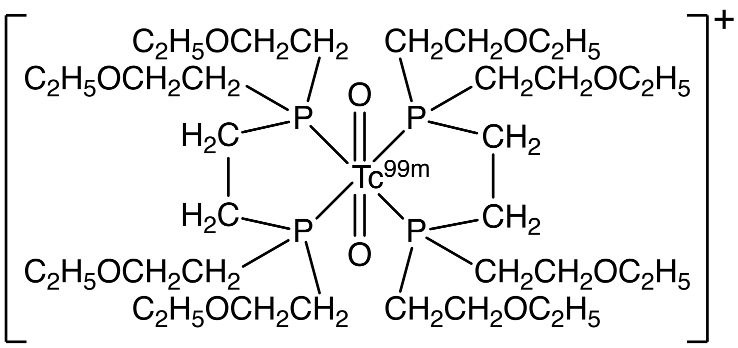


Fig. 3: the cation in Myoview.

The cation apparently interacts strongly with the mitochondria in the cardiac muscle cells. Because Myoview is *less* taken up by *damaged* heart muscle, the areas of damage show up in the image as *darker* than the healthy muscle.

Conclusion

In 1919, Rutherford discovered induced transmutation by bombarding ^{14}N nuclei with alpha particles. From 1932 onwards, bombardment particles other than alpha particles came into use. From 1934 onwards, induced transmutation delivered radioactive isotopes both of known elements and of previously unknown elements.

Induced transmutation provided radioisotopes of naturally occurring elements for use as tracers/labels in chemical investigations. But such use is less common today because of (a) new analytical techniques, (b) cheap availability in purity of stable isotopes obtained by separation, and (c) safety concerns.

Induced transmutation filled three of the six gaps preceding U in the periodic table as it had stood in 1919. It provided all the elements beyond U.

Once the elements beyond U had been discovered, a second, actinoid *f* block Ac–Lr was adopted in the periodic table, admittedly not fully comparable, electronically or chemically, with the first, lanthanoid *f* block La–Lu.

Induced transmutation is essential for producing radionuclides administered in appropriate chemical form to medical patients for imaging.

This article is extracted from a talk given at the joint meeting of the historical groups of the RSC and the IOP to celebrate the centenary of Rutherford's experiment in 1919. A generally fuller version (though lacking the material in the first Box) will appear in the proceedings of the meeting [28].

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22. For instance, Th has two 6*d* electrons and no 5*f* electron whereas the corresponding lanthanoid Ce has one 5*d* electron and one 4*f* electron: Kaltsoyannis and Scott, *The f Elements*, p. 6.

23. Kaltsoyannis and Scott, *The f Elements*, p. 47.

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The Rise and Fall of Meldola Blue

This author claims a tenuous connection to Meldola. When I first started work at University College London, I lived in Golders Green in North London. Meldola still resides there, in the Eastern (Sephardic) section of the Jewish Cemetery, along with his grandfather (d. 1828). At UCL in the Chemistry Department, I had an office adjacent to that of the just-retired Head of Department, Professor Sir Christopher Ingold. From 1921, the Meldola Medal was awarded to promising young chemists by the Chemical Society. In 1921 *and* 1922, the recipient was Ingold.

Raphael Meldola (1849–1915) was an English industrial and academic chemist, spectroscopist, naturalist, educator and lobbyist for science. Here, I trace the story of just one of his discoveries, the first oxazine dye, now named Meldola blue or Meldola's blue, among many other synonyms.

Between 1875 and 1883, Meldola worked as a scientific chemist at the Atlas Colour Works at Hackney Wick for the company then known as Brooke, Simpson, and Spiller who were well known manufacturers of coal tar colours [1]. In 1879, he published his discovery of a new blue dye in the German language *Berichte* [2]. One mole of β-naphthol was dissolved in the same weight of glacial acetic acid at 110 °C and one mole of 4-nitroso-N,N-dimethylaniline hydrochloride added slowly. When the reaction was complete, the product was washed with water, dissolved in hot ethanol and hydrochloric acid added, and after cooling, the hydrochloride of the blue dye was precipitated. He called it *β-Naphtolviolett* (β-naphthol violet). An elemental analysis and some properties were disclosed in 1881 but he declined to give an English version of the synthesis, and this paper was mostly concerned with an improved preparation of the nitrosodimethylaniline [3]. In strong solution, the dye was found to appear red by transmitted light and changed to violet on dilution. This unusual dichroism was illustrated using absorption spectra measurements. The structure of Meldola blue is illustrated in Figure 1.

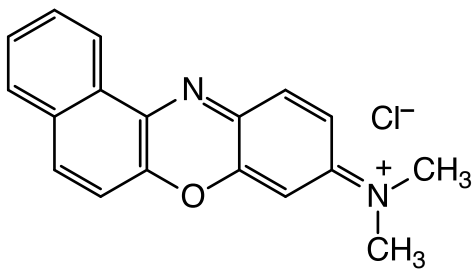

Figure 1: The Structure of Meldola blue

In the early days, the dye did not show much promise: in 1881, Meldola said "Although β -naphthol violet possesses great intensity of colour when in solution, it is not readily taken up by silk or wool, and is not, therefore, of much value as a dye-stuff." But by using the acetate of the base rather than the chloride, he found that it was possible to dye silk a dull violet colour and wool a deep shade of indigo-blue.

In those years, the British dye industry was in decline, so the manufacture of β-naphthol violet never took place in England but was produced by several companies in Germany under a variety of different names [4, 5]. By 1905, the dye was generally known as Meldola's blue [6]. The manufacturing process was soon improved by using 1 mol of β-naphthol and 2 mols of 4-nitroso-N,N-dimethylaniline hydrochloride and refluxing the mixture in ethanol for a day. Then the addition of zinc chloride solution gave a precipitate of the zinc chloride salt of Meldola's blue which was filtered and dried [6]. In 1919, the major use was to dye cheap indigo blue shades on tannin mordanted cotton [7].

The toxicity of Meldola's blue was noted early on: "The dyestuff exerts an extremely irritating action on the mucous membrane of the nostrils." [8] And again, in 1920: "It is a very fast dye but does not give pure shades. Furthermore, its dust irritates the mucous membranes so severely that many persons cannot work with it. Despite these disadvantages, however, Meldola blue is still rather widely used." [9]

By 1940, the use as a dye had declined and other uses emerged. Should you have a need to distinguish live from dead nematodes, Meldola blue will do the job. It only stains dead nematodes dark blue or purple [10].

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Chris Cooksey

Alfred Bader: A Personal Appreciation

Giants come in varied shapes and sizes. The late Alfred Bader, who passed away on 23 December 2018, aged ninety-four, was truly a giant, especially when it came to his gratitude for those who helped him in his troubled early years and his legacy to those whose lives he touched. My wife, my brother and myself were all privileged to get to know him through very different connections, connections which will be highlighted in this brief personal account and appreciation of Alfred's remarkable life.

Born in Vienna in 1924, Alfred was an able science student, with a love of Dutch art and the Bible, whose life was shattered by the *Anschluss*, the political union between Austria and Germany, in 1938. He was put on one of the first *kindertransports* to England and found himself a refugee here at the age of fourteen. Each *kindertransport* child had to have a sponsor and his was a widow, Sarah Wolff, who lived on the South Coast. A few days after his sixteenth birthday, he was arrested as a potential enemy alien and sent to an internment camp on the Isle of Man, then to a prisoner of war camp in Quebec. By pure chance he just happened to see an announcement in a Montreal newspaper from which he realised that Sarah Wolff's son, Martin, was living in Montreal. He was eventually able to contact Martin, who secured his release and helped him to gain a place on an engineering chemistry degree course at Queen's University, Kingston, Ontario, when other universities had turned him down. Academic success led to a PhD course at Harvard under Louis Fieser.

After qualification, he worked as a research chemist for a paint company in Milwaukee, Wisconsin, where he was at last able to put down roots. In his spare time, he started up the Aldrich Chemical Company with a friend in a garage, making interesting organic chemicals that Eastman Kodak did not produce. When his employer relocated, he decided to stay put and work full time for Aldrich. He developed into a brilliant businessman and built up Aldrich into a major manufacturer of organic research chemicals. A merger with Sigma Chemical's biochemical business in 1975 created Sigma-Aldrich, the largest such company in the world.

Alfred Bader toured the world speaking to the major organic research teams to understand their needs. His motive was more than just making a profit. There was genuine concern that research teams should not have to devote so much time to making their own starting materials and less common reagents; producing these commercially would enable the chemists to devote more time to carrying out actual research. It also ensured that these chemicals became available to smaller research teams which were less well-resourced to produce them in-house. Another innovation was the publication of the free journal *Aldrichimica Acta*, which included highly informative and well written reviews on the chemistry and uses of Aldrich's new ranges of chemicals. Again, whilst there was an undeniable commercial motive, it was another example of Alfred Bader reaching out to the organic research community.

Alfred Bader did not have an extravagant lifestyle; his one indulgence was to pursue his love of Dutch painting. He couldn't yet afford actual Rembrandts, so he started collecting School of Rembrandt paintings, which he proudly displayed on the covers of the annual Aldrich catalogues. As a process research chemist developing solvent extraction technology in a precious metals refinery, I recall looking forward to receiving my catalogue every year to see what would be on the cover. Alfred also started up an art gallery business with his son. When he was famously booted off the board of Sigma-Aldrich in 1992, this became his main business interest together with dispensing philanthropy. Despite his change in circumstances, he continued his contacts with and visits to his chemistry community friends.

My late older brother, a computer science professor at Queen's University, Ontario, was the first of our family to meet the Baders on one of their visits to the university. When Alfred started to donate paintings to his *alma mater*, my brother complained that this was a mixed blessing, since the University now had to incur significant ongoing costs associated with these gifts. However, over the years, Alfred showed extreme generosity towards Queen's, demonstrating his gratitude to them for starting him on his career path.

In 1992 I was given a painting of an old man which, as a schoolboy in the 1950s, I had admired hanging on the wall of my uncle's study. When my uncle died, the painting was passed from aunt to aunt and finally to me. The artist, Willem van Nieuwenhoven, was clearly Dutch but the name did not appear in the myriad of art books which I consulted; at that time there was no world wide web to browse. While clearing out a mountain of back copies of *Chemistry in Britain* from my attic in late 1993, one fell open on its Letters to the Editor page; this featured a letter written by Alfred Bader (complete with his gallery's address) asking for support for the *refusenik* chemists and other scientists in the Soviet Union, who were suffering great hardship for applying to be allowed to emigrate to Israel. I wrote to Alfred hoping he could throw some light on my Dutch artist; I only half expected a response. In fact I was delighted to receive an immediate handwritten reply requesting a photograph of the painting. In his next handwritten letter he told me when he would next be in England, together with the telephone number of his house on the South Coast. Such was his generosity of spirit that, when we spoke by phone, he was most helpful in advising me what to do next in my art research and seemed to be as interested as me in finding out about this fairly modern and relatively unknown artist. That might have been game over for my dealings with Alfred Bader but fate intervened.

My wife used to work in the accounts office of a care home in North West London. A delightful elderly Canadian couple, Sarah and Philip Orkin, used to visit the home once a week, where Sarah organised a sewing class for the residents. In 1995 Sarah wrote a privately published book chronicling her family history [1]. She showed it to my wife, who was amazed to see in it a photograph of Alfred Bader with Martin Wolff, who turned out to be Sarah's father. This connection led to our meeting Alfred Bader socially. The last occasion I met Alfred was at a lecture he gave on Dutch biblical art on a snowy December evening in London in 1995. His wife Isabel had come along to operate his slide projector before returning to the South Coast by herself. While driving her to Victoria Station, Isabel confessed to me that, whilst never telling Alfred, she was not a great fan of his dark portraits of old men which were hung all over the walls of their home in Milwaukee. It occurs to me that, if two of my aunts had not shared this same sentiment, I would never have been given my Dutch painting and then would never had any personal dealings with Alfred Bader.

By the time of his death Alfred had given Queen's many paintings including three actual Rembrandt portraits of old men. Earlier this year I was in Kingston on a family visit and took the opportunity to see works from the Bader Collection, including the Rembrandts, on display in the Agnes Etherington Art Centre at Queen's. It seemed to be an appropriate place to stand in silence for a few moments reflecting on the life and achievements of Alfred Bader, a truly great man.

For those wishing to learn more about Alfred Bader, I can do no better that direct you to his two-volume autobiography [2,3]. Sarah Orkin's book [1] contains little extra information about him.

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BOOK REVIEWS

Annette Lykknes and Brigitte Van Tiggelen (eds.), *Women in their Element: Selected Women's Contributions to the Periodic System* (Singapore: World Scientific Publishing, 2019), Pp. xxiv +531, ISBN: 978-981-120768-6, £40.00 (softback), £115.00 (hardback).

In the year celebrating the sesquicentenary of the periodic table, Annette Lykknes and Brigitte Van Tiggelen's publication draws much needed attention to women's contributions to the periodic system. The thirty-eight essays in the book highlight the diversity of women's involvement with the elements. They include accounts of well-known figures, such as Marie Curie, Jane Marcet and Kathleen Lonsdale and others less so, such as Vicenta Arnal, María Del Carmen Brugger, Trinidad Salinas, Sonja Smith-Meyer Hoel and Mary Almond. Split into six sections the book begins with old and new understandings of the elements and examines the work of Dorothea Juliana Wallich, Emilie du Châtelet and Madame Lavoisier. Later sections focus on analytical chemistry; instrumental methods; women in radioactivity; manufacturing elements; the instrumental revolution and the interface between chemistry and industry; and social activism.

In the careers of the women featured a number of themes arise. The importance of family and marital support is central to many of the stories, whilst the versatility and adaptability of a chemical training often proved invaluable as women's career paths shifted. The crucial role of influential mentors in supporting women's careers through the provision of laboratory space, recognition of research activity and introduction to networks is clearly shown. However, certain institutions and academics were more supportive of women than others. Particularly striking is the case of Celia Payne-Gaposchkin, the first student (not only the first woman) to receive a PhD in astronomy from Radcliffe College and the Harvard College Observatory in 1925. Despite the ground-breaking nature of her thesis proposing that stars were composed primarily of hydrogen and helium, she taught introductory courses without a formal appointment for most of her career. It was not until 1956 that she was promoted to full professor, the first woman to hold this rank at Harvard. Political history and the impact of two world wars also dominate the experiences of many of the women featured. This is seen most tragically in the lives of Clara Immerwahr and Stefanie Horovitz. Immerwahr, who worked on electroaffinity, collaborated with Richard Abegg, and was married to was Fritz Haber, committed suicide during World War One, an act seemingly brought about by a host of personal and professional circumstances, amplified by the horrors of the introduction of chemical warfare. Horovitz, who played a crucial role in the discovery of isotopes, later switched career to psychology. Living in Poland during the Second World War, she escaped the Warsaw ghetto, but so as not to endanger those sheltering her and her sister, they reported to the Nazi authorities and were sent to Treblinka extermination camp.

It is interesting to note the contrasting approaches taken by the authors to the book's remit. Some essays are straightforward chronological accounts of the life of the individual, whilst others focus more on the discoveries particularly pertinent to the periodic story. Others explore the wider context of women's careers in the chemical sciences and suggest a need to recalibrate how success in science is measured. One of the book's strengths is the diversity of the backgrounds of the contributors who bring expertise from a variety of disciplines and methodological approaches. The book also draws on research from on-going projects such as National Life Stories at the British Library and the efforts spearheaded by Jess Wade of Imperial College to increase the number of entries for women scientists in Wikipedia. The introductory chapter, meanwhile, provides a helpful "historiography of chemistry with women embedded" aimed at a general readership.

The book delivers an informed yet accessible style well-geared to its target audience of professional historians of science and science-curious adults. It will be of particular interest to members of the Historical Group and others with a background in chemistry who wish to learn more about the history of their field. All of the articles are accompanied by a select bibliography with helpful suggestions for further reading. Its editors are to be congratulated on bringing together a volume which highlights the complexity and multifaceted nature of science and demonstrates the importance of collaboration in scientific endeavour.

Anna Simmons
UCL

Gareth Williams, *Unravelling the Double Helix: The Lost Heroes of DNA* (Weidenfeld and Nicolson, 2019), Pp. xxx + 494, ISBN 978-1-4746-0935-7, £20.00 (hardback).

This long but ultimately rewarding book covers the story of DNA from its discovery in 1868 to the *Nature* papers of 1953 which were to lead to the Nobel Prize in Medicine (1962) to Crick, Watson and Wilkins "for their discoveries concerning the molecular structure of nucleic acids and its significance for information transfer in living material".

There are many participants in this story, well covered in this volume. The approach is truly interdisciplinary, involving bacteriology, biology, biochemistry, biophysics, chemistry, crystallography, cytology, eugenics, genetics, neuroscience, philosophy and physics. The biochemist Friedrich Miescher (1844-1895) isolated DNA in 1868 from human pus and salmon spermatozoa, calling it *nuclein*. The next major step was taken by a cytologist, Walther Flemming ("one of the few genuinely nice people in the history of DNA") whose work on dividing cells by staining techniques revealed the existence of chromosomes. The book covers these and many others: the work of those described at length include William Astbury, Oswald Avery, J.D. Bernal, Lawrence and William Bragg, Erwin Chargaff, Ray Gosling, Frederick Griffith, Albrecht Kossel, Phoebus Levene, Colin Macleod, Maclyn McCarty, Gregor Mendel, Alfred Mirsky, Thomas Hunt Morgan, Linus Pauling, Max Perutz, John Randall and Nikolai Vavilov. There is also of course extensive coverage of the work of Francis Crick, Rosalind Franklin, James (Jim)

Watson and Maurice Wilkins, the interactions (and sometimes lack of interaction) between these four, and the extent to which they relied on the work of others. It is good to see the contributions of Wilkins being given the credit that some other accounts underplay.

It is rich in incidental and anecdotal detail, e.g. Chargaff, who in 1949 reported the crucial base-pair interactions in DNA, wrote to over eighty prominent scientists around the world complaining that he had not received a Nobel Prize. The pace of the book quickens when the complex personal and research relationships between Crick, Franklin, Watson and Wilkins are explored.

The index is exemplary and there is a useful, simple glossary. The quality of the diagrams and monochrome photographs improves as the book goes on. There are of course many references, but these can be unnecessarily hard to track down because the normal procedure of simply numbering literature references is replaced by citation only of the page numbers in the book on which such references appear.

In his conclusions Williams writes of the final publication on the structure of DNA as "…the culmination of an epic saga that sprawled across eight decades…..two continents and…hundreds of people". Despite a rather slow start this is an engaging, well-assembled work covering this topic. The book is well produced and remarkably cheap - a good story, well told.

Bill Griffith
Imperial College

Peter Wothers, *Antimony Gold and Jupiter's Wolf: How the Elements were Named*, (Oxford, Oxford University Press, 2019), Pp xi + 273, ISBN 978-0-19-965272-3, £20.00 (hardback).

This book fittingly appeared during the International Year of the Periodic Table, and provides a timely study of the chemical elements. But it is not simply an etymology of elements' names, for Wothers delves into the emergence of the modern concept of an element, the discovery (and consequent naming) of many of the elements, some of the proposals for symbols to be applied to them, and along the way discusses some aspects of chemical theory

The book adopts a rough but by no means strict chronology. It opens with the seven metals known to the ancients and their attributed associations with the seven planets (including sun and moon) which led to the pictorial symbols used by the alchemists. In later years, when more metals were discovered, they were sometimes named after a recently discovered planet or asteroid, examples being plutonium and palladium. The longest known planet of them all, our own, was eventually to give its name to tellurium.

A problem that Wothers confronts with considerable success is that the modern concept of an element didn't emerge until the work of Lavoisier in the late eighteenth century. Prior to that time the seven metals known to the ancients, along with carbon and sulfur, were not recognised as being distinct from other materials that could be extracted and purified from natural sources. Confusion reigned, as newly isolated materials were sometimes substances we would now recognise as compounds rather than elements, and different materials were mistaken for each other. Wothers provides much interesting and curious information from this period. We learn that antimony (or its sulfide, stibnite) was used in processes to purify gold and silver, and because it appeared to devour the contaminating base metals it was known as the wolf of metals. In old texts such processes could be described by means of illustrations with gold being represented by a king, silver by a queen, antimony by a wolf, and lead by an old man, because of its ancient association with Saturn, the slowest moving of the planets. However the term Jupiter's Wolf of the title comes from a later period and refers to tungsten, for when attempts were made to extract tin from ores which also contained tungsten, the tin produced was of poor quality because of the tungsten impurity. Tungsten was said to devour the tin and was therefore called Jupiter's Wolf, reflecting the ancient association between tin and the planet Jupiter. We no longer talk about Jupiter's Wolf, but the etymology of the modern name tungsten is far from simple. Wothers tells the story, and also explains why we employ the symbol W for the element.

Wothers succinctly describes the crucial eighteenth-century period when air was realised to be a mixture of gases, and work on the chemistry of those gases led to Lavoisier's oxygen theory of combustion, his definition of an element as a substance incapable of being further decomposed, and the recognition of water as a compound of hydrogen and oxygen. A vital milestone was the book on nomenclature by De Morveau, Lavoisier, Bertholet and Fourcroy. An important aim of the authors was that there should be international agreement on names, and with a few exceptions this pertains to the present day. Appended to the book were the symbols of Hassenfratz and Adet, which, although not illustrated by Wothers, were a distinct advance on earlier attempts. We learn how it was Berzelius's symbols which won the day, partly because they gave no problems to typographers. But a curious omission is that no mention is made of Dalton's atomic theory. Although not immediately accepted by many chemists, it was Dalton, with his concept of the indestructible atom, who gave a theoretical explanation of the impossibility of decomposing an element. His symbols, although themselves presenting typographical difficulties, carried information on the supposed atomic arrangement within his compound atoms (molecules).

Lavoisier was adamant that his name oxygen should be retained, firmly believing that all acids would be shown to contain it, but after his death Davy showed that this was not the case. In general, from the early nineteenth century, elements were named by the discoverer, sometimes with the aid of suggestions from other chemists. Much more recently all the elements added to the periodic table have been made artificially. Names are now conferred by a committee of the International Union of Pure and Applied Chemistry, once it has satisfied itself that a few atoms have existed for a brief period.

Wothers possesses an extensive collection of rare books, and he has used these to provide many illustrations and quotations. In the main Wothers concentrates on the better-known elements; for more complete coverage the reader is referred to the monumental treatise *Discovery of the Elements* by M.E. Weeks (6th ed., 1960) which discusses every element up to Nobelium, the latest element to be known up to the time of its writing. Nevertheless Wothers has included a great deal of material in his book, and any chemist interested in the history of his subject will enjoy it. Some will wish to read it from cover to cover, while others will dip into it for information on particular elements. If anyone wants to know why manganese and magnesium have such similar names it's all there, and Wothers recounts a convoluted story with admirable clarity.

John Hudson

CHEMICAL LANDMARK PLAQUES

Chemical Landmark Plaque Commemorating H.G.J. Moseley (1887–1915): Replacement Plaque Erected in Oxford

The author observed in early 2017 that Moseley's RSC Chemical Landmark plaque, on the old Clarendon physics laboratory building in Oxford, was in poor condition. The plaque was then less than ten years old, and had been erected in a sheltered position. Nevertheless, the blue paint background was bubbling up revealing some bare metal, and the white of the raised lettering had in several places disappeared revealing underlying blue (Fig. 1).

It is with great pleasure that the author can report that the plaque has now been replaced by the RSC (Fig. 2) with the support of Professor Andrew Boothroyd of the Oxford University Department of Physics. The two plaques are identical in inscription but at the head the "RSC" logo of 2007 has been replaced by the current "Royal Society of Chemistry" logo. (Earlier in the 2000s, plaques display yet another logo, "RS•C" in distinctive font.)

Deterioration of Chemical Landmark plaques as shown in Fig. 1 is apparently not a widespread problem; there are plaques of the same general construction which are weathering well, such as the Harwell Laboratory plaque, recently moved to a more prestigious location on the Harwell Campus [1]. A more significant problem is the inconspicuousness of the earliest Chemical Landmark plaques (rectangular with black lettering on steel); replacement plaques have been made in two cases [2].

Fig 1: The plaque in March 2017. By March 2019, the area of exposed metal in the bottom left corner had increased and there was a new area of exposed metal in the bottom right corner.

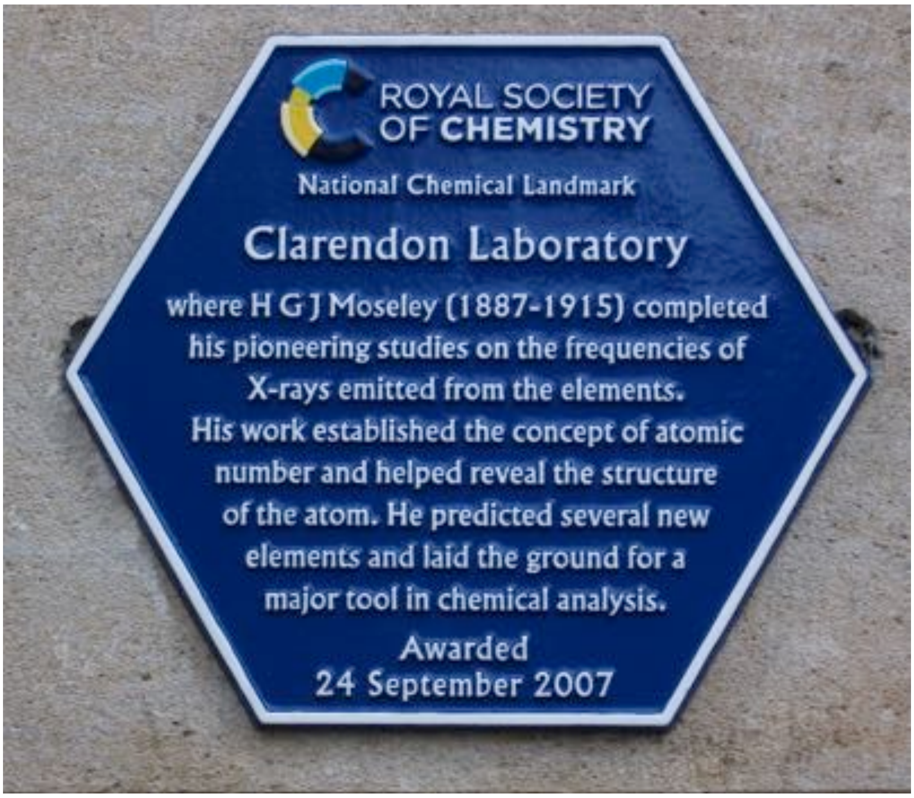

Fig. 2: The replacement plaque in November 2019.

On 19 October 2016, the Historical Group (jointly with the IOP History of Physics Group) organised a meeting to celebrate Moseley's life and work [3]. After an excellent chemical education at Eton, Moseley went up to Trinity College, Oxford in 1906 with an entrance scholarship intended for those reading chemistry, but then did his First and Second Public Examinations in mathematics and physics in 1907 and 1910 respectively [4]. His work on X-ray spectroscopy, later supplemented by that of Manne Siegbann, allowed confident determination of the charge on the atomic nucleus [5]. Because the charge on the nucleus is equal to the number of electrons in the uncharged atom, Moseley's work enabled chemistry to be on an electronic footing, even before quantum mechanics was developed in 1925-1926, with notable work by Bohr, Langmuir, and Lewis. Atomic number displaced chemical atomic weight for ordering of the periodic table; the previous use of atomic weight had achieved success only because, with relatively few exceptions, atomic weight rises monotonically with atomic number. The meeting in 2016 celebrated the centenary of the year in which Moseley might well have been awarded a Nobel Prize had he not been killed in the Gallipoli campaign of 1915 [6]. As the plaque indicates, Moseley was also the father of X-ray fluorescence spectroscopy ("XRF") as an analytical tool.

The Chemical Landmarks Scheme is part of the "Campaigning and Outreach" activity of the RSC [7]. The plaques "are publicly visible, giving everyone an insight into chemistry's relevance to everyday lives." Over fifty Chemical Landmark plaques have been presented since the first in 2001 to the Johnson Matthey Technology Centre, Berkshire [8], including some outside the UK. But for at least the last eighteen months, the Scheme has been under review and applications for new plaques have not been invited.

A useful though not entirely reliable or complete list of Chemical Landmark plaques appears in Wikipedia [9], and there is also an incomplete list of RSC plaque presentations in the Thames Valley [10], each with photographs.

In addition to monitoring the condition of some existing plaques as discussed above, the Historical Group took the lead in securing the erection in 2015 of a plaque at Sir Humphry Davy's place of apprenticeship in Penzance [11].

References

1. Michael Jewess, *RSCHG Newsletter*, Winter 2019, 75, 21-31 (hard copy), 11-16 (online).
2. Alan Dronsfield *RSCHG Newsletter*, Summer 2014, 66, 51-53 (hard copy), 24-25 (online); Bill Griffith and Michael Jewess, *RSCHG Newsletter*, Winter 2018, 73, 54-57 (hard copy), 28-32 (online), see final paragraph. Circular white-lettering-on-blue plaques to Calvert, Frankland, and Dalton appear on the Wikipedia page (reference [9] below), and while they bear a sole RSC attribution they do not carry the designation "Chemical Landmark" and presumably were outwith the scheme, though contemporary or probably so.
3. Russell Egdell, *RSCHG Newsletter*, Winter 2017, 71, 35-38 (hard copy), 19-21 (online).
4. Roy MacLeod, Russell G. Egdell, and Elizabeth Bruton (eds), *For Science, King, and Country* (London: Uniform, 2018), Chapter 1 (Clare Hopkins). In Oxford, then as today, success in two "public" – i.e. university,

not college – examinations were necessary to obtain a bachelor's degree, and the subjects taken do not necessarily have to correspond. College undergraduate entrance scholarships no longer exist; but at least as late as the 1960s might be retained by an undergraduate who switched subject (author's personal knowledge).

5. MacLeod, Egdell, and Bruton, *For Science, King and Country*, Chapters 2 (Neil Todd), 3 (Kristen M Frederick-Frost), 4 (Eric Scerri), and 8 (Egdell).
6. MacLeod, Egdell, and Bruton, *For Science, King and Country*, Chapters 5 (Elizabeth Bruton) and 6 (Robert Marc Friedman).
7. https://www.rsc.org/campaigning-outreach/outreach/get-involved/, accessed 4 November 2019.
8. David Phillips for the RSC, quoted in Bill Griffith, *RSCHG Newsletter*, Winter 2015, 67, 40-41 (hard copy), 19-20 (online). Also a broken link to an RSC News item referred to against the Johnson Matthey Berkshire plaque on the Wikipedia page (reference [9] below).
9. https://en.wikipedia.org/wiki/List_of_blue_plaques_erected_by_the_Royal_Society_of_Chemistry, accessed 4 November 2019.
10. https://www.rsc.org/Membership/Networking/LocalSections/ThamesValley/TVRSCLandmarkAwards.asp, accessed 4 November 2019.
11. Michael Jewess, *RSCHG Newsletter*, Winter 2016, 69, 32-38 (hard copy), 16-19 (online).

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MEETING AND CONFERENCE REPORTS

William Crookes (1832-1919)

Saturday 19 October 2019, Royal Institution

2019 marked the centenary of the death of William Crookes. Journalist, chemist, photographer, spiritualist, businessman, sometime Secretary of the Royal Institution and President of the Royal Society of London, Crookes was a key figure in the science of the second half of the nineteenth century and beginning of the twentieth. On 19 October 2019 the Society for the History of Alchemy and Chemistry, the Royal Society of Chemistry Historical Group and the Royal Institution marked this anniversary by holding a meeting at the Royal Institution to examine various aspects of Crookes's extraordinary career and his place in science. Over fifty people attended the meeting, which was also part of the ChemFest celebrations of the sesquicentenary of the periodic table.

'Two Parallel Lines'? The Trajectories of Physical and Psychical Research in the Work of William Crookes

Richard Noakes (Exeter University)

In 1905 the English journalist Harold Begbie interviewed William Crookes for a leading magazine of fashionable London society. Begbie gathered from Crookes's responses that the veteran chemist regarded "physics and psychics" as "two parallel lines" that could never nurture each other. Yet Crookes seemed to hold out hope that parallelism would eventually turn to convergence with physicists' studies of the apparently immaterial basis of matter and psychical researchers' studies of the physiological basis of telepathy.

Noakes' paper argued that Begbie was either misunderstanding Crookes or Crookes was being disingenuous because Crookes's approaches to psychical phenomena had been strongly physical since the 1870s when he began systematically investigating spiritualism. This was explored in relation to Crookes' investigations of an apparent 'psychic force' exuded by the body, materialised spirit forms and 'brain wave' theories of telepathy.

William Crookes: A Life in Photo-Chemistry

Kelley Wilder (De Montfort University, Leicester)

Sir William Crookes was a well-known photographer at the beginning of his career, but he is best known for his other achievements, later in life. Wilder's paper argued that Crookes' photographic knowledge and practices informed his experimental career throughout his life, even after he apparently left mainstream photographic circles. Using notebooks and recently discovered caches of photographs, she argued for a rethinking of Crookes' use of photography throughout his lifetime, showing how everything, from his note-taking to his experimental practices was indebted to photographic practices. While half the notebooks remain secluded in the Science Museum due to concerns over radioactivity, this study will remain incomplete, but it is suggestive of new directions in understanding Crookes' various activities throughout his scientific career.

William Crookes and Michael Faraday

Frank James (Royal Institution and UCL)

In this talk James considered the three main interactions in the 1850s and 1860s between Crookes and Faraday, his senior by some forty years. According to a much later account by Crookes, he first met Faraday at a couple of table-turning seances arranged in June 1853 by the Secretary of the Royal Institution and close friend of Faraday's, John Barlow, whom Crookes later described as his pupil at the Royal College of Chemistry. Unfortunately, Faraday's notes of the seances do not refer explicitly to Crookes's presence. At these meetings Faraday demonstrated versions of the detector that he had devised to show what he regarded as the unconscious involuntary motions of the table-turners in causing the effect. At this point it is doubtful if Crookes was much concerned with such phenomena, but later used Faraday's work as a justification for his own scientific study of them. Their second interaction was Crookes's role in publishing the last two series of Faraday's Christmas Lectures for juveniles at the Royal Institution delivered in 1859/60 and 1860/61. Until then Faraday had resisted all (including some very generous) offers to publish his lectures, believing that the printed text could not convey the vivacity of the lectures. James suggested that he may have changed his mind to contribute to improving public scientific knowledge, the want of which had been evinced, in his view, during 1853 (and after), by the widely held belief in table-turning and related phenomena. Crookes was especially keen to obtain copy for his weekly *Chemical News* (begun at the end of 1859) and was only too pleased to publish not only almost verbatim accounts of Friday Evening Discourses at the Royal Institution, but also persuaded Faraday to let him publish his Christmas Lectures. This culminated in the publication of *The Chemical History of a Candle*, which by being continuously in print since 1861 and translated into more than a dozen languages, is arguably the most popular science book ever published. The final interaction between Faraday and Crookes involved the latter's spectroscopic discovery of the chemical element thallium in 1862, which, much to Crookes's annoyance, was also credited to the French chemist Claude-Auguste Lamy. Faraday helped support Crookes's claim by, for example, undertaking magnetic studies of the new metal, but also by nominating him, successfully, from personal knowledge, to be elected a Fellow of the Royal Society of London. Thus, through these three areas Faraday played a significant role in developing Crookes's early career, from which he never looked back.

George Gabriel Stokes (1819-1903) – Crookes's "Invisible Helper"

Paul Ranford (UCL)

The title of this talk was taken from William Brock's biography of the British physicist William Crookes (1832-1919) in which Brock described Stokes as "one of Crookes' many 'invisible' helpers" (W.H. Brock, *William Crookes (1832-1919) and the Commercialization of Science*, London: Routledge, 2016, p. 11).

Crookes himself seemed in no doubt about the value of Stokes' to his work – in 1907 he admitted (perhaps with some hyperbole) that "…if what I owe to Stokes is deducted from my work there will be precious little left I can claim for my own!" (Crookes, in Larmor, *Stokes – Memoir and Scientific Correspondence Vol. 1*, Cambridge: CUP, 1907, p. 362) The talk demonstrated the significant impact of Stokes on Crookes' scientific work, something which Ranford argued is inadequately recognised in the historical literature.

George Gabriel Stokes was an Irish-born physicist and mathematician, best known for his contributions to fluid-flow theory (the "Navier-Stokes" equations) and his discovery of fluorescence. He withdrew from his own original researches shortly after becoming joint-Secretary of the Royal Society to undertake a long period of administration in British science, culminating in his Presidency of the Royal Society from 1885 to 1890. Throughout his time as joint-Secretary, Stokes acted as Editor of the Royal Society's main and highly prestigious scientific publications, *Transactions* and *Proceedings*. In scientific politics this was an enormously powerful position in which Stokes provided significant (if often inconspicuous) contributions of experimental ideas and rigorous mathematical theory to the work of Victorian scientists. Of all of these, Crookes' debt to Stokes seems the greatest <u>bar</u> that owed by Stokes' closer – and even more influential – friend William Thomson (later Lord Kelvin).

The significance to science of the collaborative relationship between Crookes and Stokes is evident from their correspondence, comprising over 200 letters spanning the period from 1856 to 1901. Stokes' input involved the provision of mathematical theory and suggestions of practical techniques to underpin and extend Crookes' experimental results. He provided solutions to problems of precision measurement, helped Crookes to avoid error in the interpretation of experiments on the radiometer and other apparatus, and resisted his submissions of papers favourably reporting fraudulent spiritualist claims made by mediums and table-turners. (It seems likely that this resistance was as much a consequence of Stokes' convictions as a devout evangelical Christian on the state of the human spirit after death, as it was of the need to avoid controversy in Royal Society publications.)

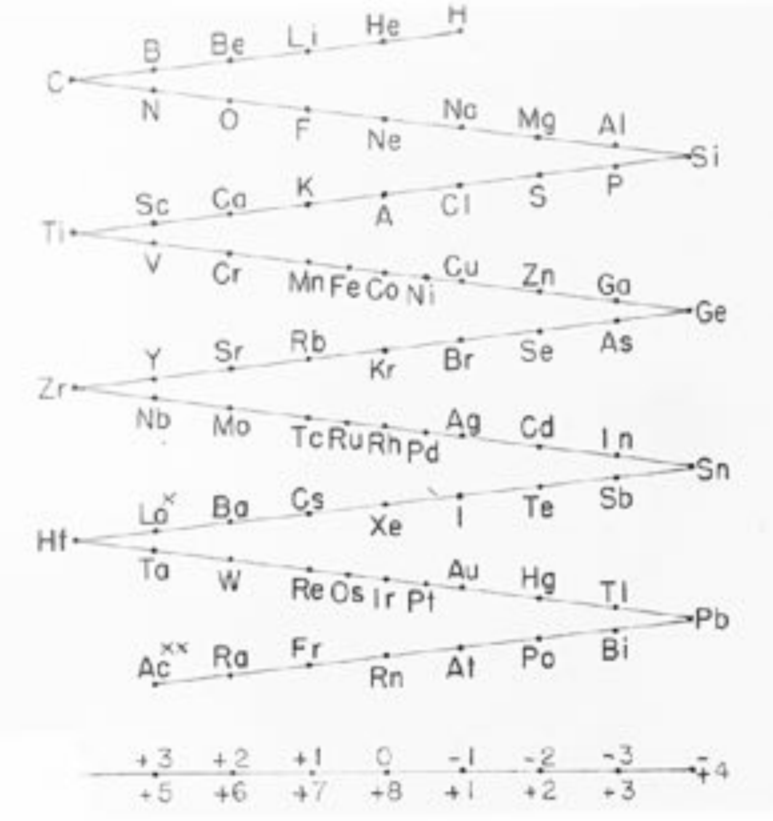
In 1879 Stokes recognised that Crookes had "really opened out quite a new field of research in … recent experiments" (Stokes in a letter to his father-in law, the Irish astronomer Thomas Romney Robinson, 6 April 1879) with the development of the Crookes' tube, a glass vessel evacuated to a very high degree of vacuum. The ambiguous nature of cathode rays was examined by Crookes and Stokes together, and they concluded that the rays were particulate rather than electromagnetic in nature, convincing British scientists of this fact despite the objections of German scientists. J.J. Thomson's discovery of the electron soon followed.

Crookes' extraordinary technical ability in the development of the vacuum tube, his experimental insights in new fields of investigation (in particular cathode rays) and Stokes mastery of mathematical physical theory combined to produce extensions of knowledge beyond any that could have been achieved by either acting alone.

The Key to the Deepest Mystery of Nature: Crookes, Periodicity and the Genesis and Evolution of the Elements

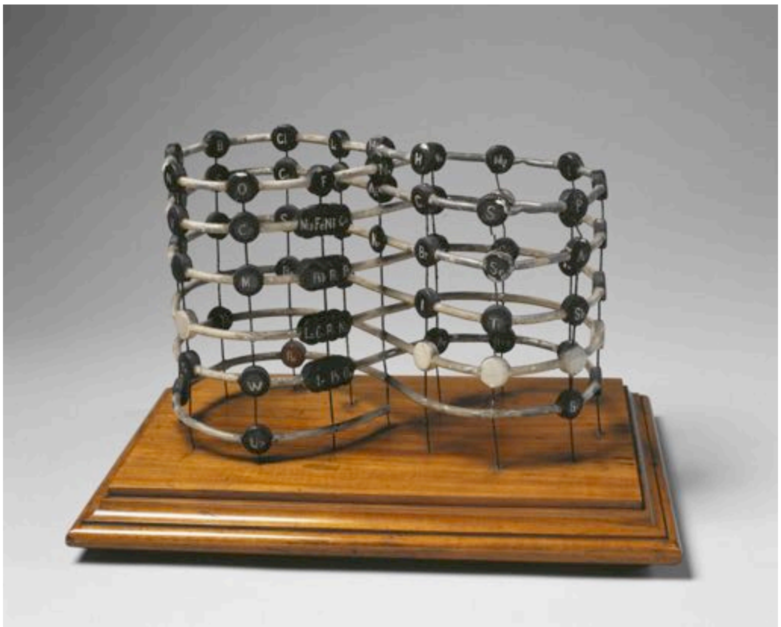
William Brock (University of Leicester)

By the mid-1880s the periodic system was being used in teaching in most of the UK's schools of chemistry. Following the identification of Mendeleev's predicted elements (gallium, 1875); scandium, 1879), Crookes had translated from the French, and serialised, a long French paper of Mendeleev's that extolled the value of the table. Typical of tables in the 1880s was the grid of seven horizontal periods and eight vertical groups used by the Irish chemist J. Emerson Reynolds at Trinity College Dublin. Reynolds was well aware that that there had been speculations by the astronomer Norman Lockyer, the Canadian geochemist Sterry Hunt, and the Dundee chemist Thomas Carnelley that the periodic system seemed to imply that so-called elements were compounds. Indeed, contemporary organic chemists often drew attention to the analogy between the periodic table and homology in the paraffin series of hydrocarbons. Reynolds appears to have resisted such speculations, apart from drawing attention to the anomaly of hydrogen which sat in isolation in the first period. This did encourage him to ponder whether there were unknown lighter elements than hydrogen, of which the solar helium (not yet identified terrestrially) might be an example.



Reynolds' Zig Zag Periodic System, 1886, taken from *Chemical News*

Crookes had always been fascinated by Prout's hypothesis that the elements might be composed from an extremely light fundamental material, *protyle*, and the run of his *Chemical News* shows him frequently giving house room to speculations about its validity. He was also a convinced believer in Darwin's theory of evolution. In the spring of 1886 Crookes found himself in Dublin on business and called on Reynolds. He was struck by an unusual "zig-zag" form of the periodic table that was fixed to the laboratory wall for teaching purposes and requested Reynolds to write up an explanation for readers of *Chemical News*. The chart and explanation appeared on 2 July 1886. In it Reynolds explained how he used a knotted piece of vibrating string (the knots were elements arranged in periods of seven) and told students to imagine how the different amplitudes might represent a change of property along a period. This was just the sort of analogy that Crookes needed to add a bit of excitement to his forthcoming Presidential Address to Section B (Chemistry) that was to meet in Birmingham in September 1886. In it he turned Reynold's zig-zag upside down (so that hydrogen was at the top and heavier elements at the bottom) and used the analogy of a swinging pendulum. In its turn, the zig-zag traced by the pendulum became a cooling curve, with new elements condensing and being manufactured as the temperature dropped or violently fluctuated during distant cosmological and geological epochs. It therefore also plotted an evolutionary curve. The beauty of the analogy was that it could be dressed up in mathematical language (courtesy of his constant "hidden helper", the mathematical physicist George Stokes), and that it could also be transformed into a three-dimensional model that his assistant James Gardiner unveiled at the Chemical Society three years later. The rare earths that he was currently trying to separate and differentiate became mixtures that he called *meta-elements*, while atomic weights (like chlorine's) that diverged from a whole number were also *ad hoc* mixtures of Cl =35 and Cl = 36.



Crookes' Spiral Periodic System, reproduced under CC-BY-NC-SA licence courtesy of the Science Museum Group

The Crookes Family Grave at Brompton Cemetery with a radiometer on top spinning in the sunlight.

Reproduced by permission of the Catalan film-maker Gerard Gil, who attended the meeting.

As to the identity of the evolving *protyle*, this elegantly fitted the "fourth state of matter", or "radiant matter" that he had identified as the cause of the radiometer effect that he had studied during the previous decade and the "cathode rays" that he was currently exploring in radiometers fitted with electrodes (the Crookes tube). As was usual with his "big" set-piece speeches and presentations, Crookes ended the 1886 address with a fine example of purple prose that suggested that with the fourth state of matter and Prout's evolutionary model of periodicity, he had touched the borderland between known and unknown where lay "ultimate realities, subtle, far-reaching, wonderful". This can be read as a forecast of the structured atom and the relation between matter and energy; but it also clearly referred back to Crookes's psychic investigations of the 1870s when he had hoped to find linkages between a material world and a more subtle spiritual world with which it might one day be possible to communicate. Quoting Edmund Spenser's *Fairie Queene* (1590), Crookes noted there had been unknown geographical regions of the world that remained unknown until discovered by intrepid explorers. "And later times things more unknowne shall show. Why then should witless man so much misweene [wrongly think]/ That nothing is, but which he have seene?"

Report on the Twelfth International Conference on the History of Chemistry

29 July to 2 August 2019, Maastricht

Some 120 historians of chemistry met in Maastricht for the 12th International Conference on the History of Chemistry (12ICHC). The meeting was organized by the EuChemS Working Party on the History of Chemistry and hosted by the Maastricht University under the auspices of the Royal Netherlands Chemical Society (KNCV), the Maastricht University, and with the support of the Science History Institute, the Solvay company, the Polymer Research Platform (DPI), the Society for the History of Alchemy and Chemistry (SHAC), the Holland Chemistry, the ACSeBooks and the Linda Hall Library. The local organizing committee was chaired by Ernst Homburg; Christoph Meinel and Ignacio Suay-Matallana served as chairs of the programme committee.

The keynote lectures were given by Ernst Homburg, who presented on the Dutch contributions to the history of chemistry; Lissa Roberts, who talked about the relations between history of chemistry and global history; Marco Beretta who invited the audience to explore Lavoisier and contemporaries' laboratories including the lesser-known apparatuses or instruments; and Carsten Reinhardt who gave an insider's look into the global chemical industry in the twentieth century and discussed the changing role of chemistry for science, technology and society at large. The history of chemistry in Japan was the central issue of the lecture of the Society for the History of Alchemy and Chemistry's 2018 Morris Award winner, Yasu Furukawa.

Presentation of the 2018 Morris Award to Yasu Furukawa

The general programme offered a wide range of research topics and historiographical perspectives on the history of alchemy and chemistry, chemical analyses, sites of chemical knowledge, material and visual culture of chemistry, women in STEM and chemical industries, among many others. There were two special panels: "150 years of the Periodic System" organized by Gisela Boeck, Annette Lykknes, Isabel Malaquias and Luis Moreno-Martínez and "IUPAC and the other international scientific organizations: competition or synergy?" organized by Brigitte Van Tiggelen and Danielle Fauque. The conference closed with two roundtables. The first one with Alan Rocke, Ernst Homburg, Peter Ramberg, Marco Beretta and Marcus Carrier focused on the upcoming six-volume Cultural History of Chemistry: ancient, medieval, early modern, eighteenth, nineteenth and twentieth century chemistry and discussed the importance of engaging history of chemistry with cultural topics, such as art, genre or pedagogy. The second roundtable was chaired by Brigitte van Tiggelen with John Christie, Jeff Johnson, Annette Lykknes, Cyrus Mody and Peter Morris as discussants. It was devoted to the challenge of writing the twentieth-century history of chemistry.

A Roundtable Discussion at ICHC

The Working Party of the History of Chemistry business meeting was also held on the final day of the conference. Annette Lykknes was nominated chair-elect, and Ignacio Suay-Matallana was re-elected as secretary of the Working Party. In addition, Isabel Malaquias was elected as vice-chair, and Yoanna Alexiou was appointed as communications officer.

Thanks to the generous sponsorship of the conference, there were several excellent social events including a visit to the Restoration Workshop Limburg (SRAL), a leading institution in the restauration and conservation of painting, followed by a visit to the Bosch brewery in Maastricht, a wonderful conference dinner on board a boat going down the Maas river and back, and trips to Fort Sint Pieter and the underground tunnels associated with it. On the day after the conference there was a tour to Liège, Kelmis (the former microstate of Neutral Moresnet) and Stolberg, three places connected with the zinc and brass industries.

12ICHC was altogether an excellent well-attended and well organised meeting aided by the splendid summer weather which fortunately had cooled down from the record-breaking heatwave of the previous week. I reckon it was the best ICHC since the 8ICHC in Leuven in 2007 which was also well sponsored. The next ICHC will be held in Vilnius, Lithuania, between 18 and 22 May 2021.

Peter Morris
(based on a report by Luis Moreno-Martínez and Silvia Pérez-Criado)

Reception to Mark the Life of Joseph Priestley in Nantwich

A recent reception at Nantwich Museum on 27 September 2019 enabled Museum Members, members of the RSC (and Historical Group Chair Peter Morris) to celebrate the life of one-time resident of Nantwich, Joseph Priestley, the famous scientist, theologian and teacher, and the International Year of the 150-year-old Periodic Table of Chemical Elements. The reception was sponsored by the North Staffordshire Local Section of the RSC, CICAG and the Historical Group, who also sponsored the exhibition, "From Nantwich to Oxygen: Joseph Priestley's Journey of Discovery", which was in the Millennium Gallery at the Museum until 26 October 2019. The museum also received a grant from the RSC's International Year of the Periodic Table fund. The development of the exhibition was led by Historical Group member Helen Cooke, the Vice-Chair of Nantwich Museum Board of Trustees, and was ably supported by Nantwich Museum staff and volunteers.

In his keynote speech, Professor Mark Ormerod, Deputy Vice-Chancellor and Provost at Keele University, noted Joseph Priestley's contribution to an understanding of chemistry and described the periodic table as a thing of beauty for its simplicity and elegance. He attributed Priestley's achievements to his dissenting background which imbued in him the "capacity to think" and a philosophy of problem-based learning. The Mayor of Cheshire East Council, Cllr Burkill, congratulated the Museum on its interesting and informative exhibition, describing Joseph Priestley as a pioneering scientist and true polymath, someone of whom Nantwich could be proud. He revealed his own scientific background, having been at one time a chemistry teacher. The Mayor of Nantwich Town Council, Cllr Moran echoed Mayor Burkill's appreciation for the contribution made by volunteers and recalled Priestley's remark in the eighteenth century of the good nature and friendliness of the people of the town, noting how this remains true today.

Whilst in Nantwich Priestley learned to play the flute (which was more like the modern recorder). He did not claim to be proficient in the instrument but found the music enjoyable. A most memorable rendition, on a replica of an English flute of Priestley's time, of "How brightly shines the morning star" was given by local musician and early music expert David Owen. Although attributed to J.S. Bach, who used it in numerous works, it was not necessarily composed by him. Nevertheless, Priestley might have played it whilst living in the town. Katherine Haxton, Senior Lecturer in the School of Chemical and Physical Sciences at Keele University, then demonstrated the excitement and fascination of chemistry in a most practical way using the generation of oxygen from hydrogen peroxide and washing up liquid to make dramatic "elephant's toothpaste".

Nantwich Museum Priestley Reception: From left to right, David Owen, Musician, Cllr Carole Thomas, Nantwich Town Council, Mayor of Nantwich Town Council Cllr Arthur Moran, Mayor of Cheshire East Council Cllr Barry Burkill, Professor Mark Ormerod, Keele University, Dr Katherine Haxton, Keele University, Dr Helen Cooke, Vice-Chair Nantwich Museum Board of Trustees (Photograph Paul Topham, courtesy of Nantwich Museum).

The exhibition was very interesting, but as it was not possible to get artefacts from the Science Museum, many of the artefacts on display were from Harris Manchester College, Oxford, the successor of Warrington Academy where Priestley worked after leaving Nantwich. This meant that there was not a strong chemical element to the exhibition but some very personal items such as Priestley's glasses. Some of the exhibition material is now online at:

http://nantwichmuseum.org.uk/from-nantwich-to-oxygen-joseph-priestleys-journey-of-discovery-2/.

Helen Cooke has also written a pamphlet about the life of Joseph Priestley in Nantwich which was both accurate and well written. For example, Priestley probably pioneered the scientific education of girls while he was in Nantwich. The museum also stocks a booklet on the Nantwich brine industry which draws on the research for the late Historical Group member George Twigg. Either of the booklets can be obtained by post from the Nantwich Museum for £3.95 for one booklet and £6.90 if both are purchased at the same time, including UK postage. Please contact the museum at enquiries@nantwichmuseum.org.uk for further details.

Peter Morris

Dyes in History and Archaeology Meeting Report

The thirty-eighth annual meeting of Dyes in History and Archaeology took place in Amsterdam on 7-8 November 2019. The meeting was organized by the University of Amsterdam (UvA), in collaboration with the Cultural Heritage Agency of the Netherlands (RCE), the Rijksmuseum and the ErfgoedAcademie (Heritage Academy). The meeting was held in the University of Amsterdam Theatre and ninety-one delegates attended. There were twenty-three twenty-minute oral presentations and twenty-three posters displayed over the two days by delegates from twenty countries.

There was a wide range of topics. Three presentations were about diverse aspects of lac dye, the red insect dye from *Kerria lacca*: the trade and production of lac dye in the medieval period and today in north-east India; its use in eighteenth-century dyeing in France and England; and up to the minute identification in sub-millimetre samples using UV-visible diffuse reflectance spectrophotometry with fibre optics (FORS). Several presentations and posters were on synthetic dyes, including Vincent van Gogh's use of coal tar inks in drawings; the use of a particular group of triphenyl methane dyes by the Dutch Talens company to make pigments, from an investigation into their extensive archives; and the conservation of a huge repository (over 10,000 items) of synthetic dyes dating from the 1880s to 2000 at the Niederrhein University of Applied Sciences at Krefeld. This is a significant problem that is faced by many collections. Other presentations dealt with unusual or poorly understood plant dyes, such as that from *Justicia spicigera*, scientific investigation of dyes and their properties and analytical or sampling methods. Case studies about re-making and re-enacting of historical recipes to reproduce the Burgundian blacks or the madder reds of Bronze Age Xinjiang, and the announcement of the Finnish BioColour project showed the growing interest in contemporary uses of natural colorants.

The traditional format was followed. A welcome reception was held on the Wednesday evening, the very enjoyable conference dinner at the Indonesian restaurant Kantjil & de Tijger on Thursday and the Saturday outing to Leiden to visit the Volkenkunde Museum (National Museum of Ethnology) and the recently reopened Museum De Lakenhal, a city museum of history and fine art, in earlier times the home of the Staalmeesters where woollen cloth was brought for inspection.

The next meeting will be held in Sibiu, a city in Transylvania, central Romania, in October 2020.

I did not attend this meeting but have received invaluable advice from Maarten van Bommel, Regina Hoffman-de Keijzer, Dominique Cardon and Jo Kirby. For a copy of the abstracts, 1.65 MB PDF, contact chriscooksey8@gmail.com.

Chris Cooksey

FORTHCOMING RSCHG MEETING

Royal Society of Chemistry Historical Group George Porter Meeting

15 October 2020, Royal Society of Chemistry, Burlington House

This meeting will explore the life and career of the Nobel Prize-winning chemist George Porter (1920-2002). The programme will appear in the summer 2020 *Newsletter*.

OTHER MEETINGS OF INTEREST

History of Anaesthesia Society: Annual Meeting,

26-27 June 2020, Prince Rupert Hotel, Shrewsbury

For further details please see: http://www.histansoc.org.uk/events.html

FORTHCOMING CONFERENCES

British Society for the History of Pharmacy Annual Conference

27-29 March 2020, Manchester

The annual conference, themed around *materia medica* and plant-based medicines, will be held at the Copthorne Hotel, Salford Quays. It will include a visit to the *materia medica* collection at the Manchester Museum and an optional pre-conference visit to Manchester University's School of Pharmacy. For further details please visit:

https://www.bshp.org/events/ShowEvent.asp?E=31

BSHS 2020 Annual Conference

The British Society for the History of Science 2020 Annual Conference, will be held in Aberystwyth, home of the National Library of Wales and Aberystwyth University, from Wednesday 8 July to Saturday 11 July.

For further information please visit: http://bshsaberystwyth2020.info/

ESHS Conference

The 9th International Conference of the European Society for the History of Science (ESHS), hosted by the Centre for the History of Universities and Science at the University of Bologna (CIS) and by the Italian Society for the History of Science (SISS), will take place in Bologna, from 31 August to 3 September 2020. The theme of the 2020 meeting is "Visual, Material and Sensory Cultures of Science", a very broad and inclusive topic. This theme will provide ample opportunity to take stock and reflect on "sensory cultures" and on the "visual turn", to assess their strengths and weaknesses, but also to explore their relationship with competing or overlapping historiographical trends such as the material and global history of science, medicine and technology.

For further information please visit:
https://sites.google.com/view/eshsbologna2020/home