# Historical Group

## NEWSLETTER
## and
## SUMMARY OF PAPERS

### No. 78 Summer 2020

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## COMMITTEE



https://www.qmul.ac.uk/sbcs/rschg/
http://www.rsc.org/historical/

# RSC Historical Group Newsletter   No. 78  Summer 2020

## Contents



## From the Editor

Welcome to the summer 2020 RSC Historical Group Newsletter. I sincerely hope it finds you and your loved ones safe and well and that it provides some interesting reading in these unprecedented times. Regular readers will notice that whilst the format remains the same the content is slightly different from usual. In the absence of reports on the group's meetings and other events, the focus is very much on short articles. I am particularly grateful to the authors who have contributed to this issue: Alan Dronsfield, Peter Morris and (the late) Trevor Brown who answer the question "Who really invented the Grignard Reaction?"; Richard Buscall for his article "The Birth of Spectroscopy and the Chemistry of the Sun"; Fred Parrett who kindly wrote up his lecture to the SCI London Group on "The Chemists War: IUPAC and the SCI"; and Gordon Woods for his article looking at Dmitri Mendeleev and Great Britain.

There are three book reviews in this issue with the titles featured as follows: Glen E. Rodgers, *Traveling with the Atom – A Scientific Guide to Europe and Beyond;* Clare E. Wilkes, *Framed by a Smoking Gun: The Explosive Life of Colonel B.D. Shaw*; and Kit Chapman, *Superheavy: Making and Breaking the Periodic Table*. My thanks to Bill Griffith and John Nicholson for these reviews.

Finally, I would like to thank everyone who has sent material for this newsletter, particularly the RSCHG Committee and a wider group of colleagues who have responded to my appeals for content. I also want to thank the newsletter production team of Bill Griffith and Gerry Moss, and also John Nicholson, who liaises with the RSC regarding its online publication.

Having recently revised the text encouraging submissions on the RSC Historical Group website, I would like to remind readers that contributions of articles of around 2,500 words in length on topics of current interest in the history of chemistry are warmly invited for inclusion. The winter 2021 issue will also be centred around short articles and I am very happy to discuss possible contributions prior to submission. The deadline for the winter 2021 issue will be **Friday 5 December 2020**. Please send your contributions to a.simmons@ucl.ac.uk as an attachment in Word. If you have received the newsletter by post and wish to look at the electronic version, it can be found, along with past issues and guidelines for contributors at:

https://www.rsc.org/historical or https://www.qmul.ac.uk/sbcs/rschg/.

Anna Simmons, UCL

## ROYAL SOCIETY OF CHEMISTRY HISTORICAL GROUP NEWS

### From the Chair

I am writing to you now in an unprecedented national lockdown. Our country has been hit by a major pandemic, the like of which has not been seen since the Spanish flu of 1918-1919. First and foremost, I very much hope that you and your loved ones are well and that you all continue to be well. The good continuing health of all of us is most important. Unfortunately, this pandemic has also led to the postponement of our meetings until 2021. "The Handed World: 150 years of Chiral Molecules", organised by Michael Jewess, was supposed to take place on 19 March, but we postponed it when it became clear that such a meeting in London could be very risky for our older members - in the event, the RSC closed Burlington House on 13 March anyway. At the advice of the RSC, the second meeting of 2020, on Sir George Porter, has also now been postponed. With the possibility of a second wave of infection, it is impossible to give dates for the meetings at the moment, but we will of course keep all our members posted about these meetings by email and through our website.

We will continue to produce the newsletter and will also be holding online webinars using Zoom (see details below). Our first webinar was held on 14 July when the Group's former Chair Alan Dronsfield gave a talk entitled "Bichloride of Methylene: anaesthetic or paint-stripper?". John Hudson has also offered a historical talk entitled "Josiah Wedgwood Potter and Scientist", which he has previously given to RSC Local Sections, U3A Science Groups, etc. With my assistance, the images and associated notes are now available in the form of a relatively small (1 MB) PDF file. His presentation makes the point that Wedgwood's success as a potter was at least in part due to the scientific approach he brought to pottery manufacture. This PDF is available to members of the Historical Group for their personal use, and is sent on the understanding that it is not to be shared with any other person. If you would like a copy send an email request to John at johnhudson25@hotmail.com. Please use the subject line "Wedgwood Talk".

I am sorry to report the death of our former Chair Noel Coley on 8 May at the age of ninety-two. He was on the committee of the Historical Group for nearly thirty years and was its Chair between 1994 and 1998. I would like to pay tribute to his long service to our group. We were represented at his funeral on 11 June by John Nicholson and I would like to thank John for undertaking this duty in these difficult times. An account of Noel's life will be found later in this issue of the newsletter.

It gives me great pleasure to conclude this piece with the news that our membership secretary Bill Griffith has just been given the 2020 Award for Exceptional Service by the RSC for his work for the Historical Group: many congratulations, Bill, it is well deserved.

Peter Morris

## New "Lockdown" Webinar Series

In the second talk in our new series of short lockdown webinars, our former Chair Alan Dronsfield will give a talk entitled "Cocaine to Novocaine - a Chemical Journey". This will be presented on Zoom on Tuesday 11 August at 2 pm, but please log on before the meeting from 1.45 pm onwards.

*Cocaine was one of the few drugs that revolutionised nineteenth century medicine and dentistry. In the former it meant that patients could be operated upon without the necessity of putting them to sleep and, in the latter, it permitted painless fillings and other procedures. Yet it was not without risk and some patients died. Chemists were charged with coming up something better and safer. The structural features of cocaine, as they were discovered, were incorporated into synthetic local anaesthetics. The most effective of these was Novocaine. First used in 1905 it survived until the late 1950s. Several older readers of this Newsletter may well have experienced it in the dental chairs of their childhood.*

This talk is open to all RSC Historical Group members. You do not need to already have the free version of Zoom to be able to take part as Zoom will connect you to the platform remotely. There is no need to have a webcam or a microphone as the audience will be asked to turn off their video and mute themselves to avoid any possible complications. Questions for the speaker should be posted via the chat function on Zoom during the meeting rather than at the end. As we will be using free Zoom this time, the numbers taking part will be limited to ninety-five participants. As invitations will be sent out on a first come first served basis, please register for this meeting as soon as possible.

Future webinars are being planned for the second Tuesday of each month at 2 pm. The topics will include Joseph Priestley, mauve, and the early history of NMR in Britain.

If you would take part in this webinar, send an email request to Peter Morris at doctor@peterjtmorris.plus.com. Please use the subject line "Novocaine Talk".

Peter Morris

## RSC 2020 Award for Exceptional Service

Historical Group's former Secretary and current Membership Secretary, Bill Griffith has been presented with this award for outstanding service to the RSC through the Historical Group and for advising on activities celebrating the history of the chemical sciences. Bill has written fifteen chemical-historical papers including papers on Charles Hatchett and William Wollaston and in 2018 wrote, with Hannah Gay, *The Chemistry Department at Imperial College London: A History, 1845-2000*. His chemical work centred on compounds of the six platinum metals, with some (particularly ruthenium and osmium) proving very effective as catalysts in the oxidation of sensitive organic groups. Further information on Bill and the Award can be found at:

https://www.rsc.org/awards-funding/awards/2020-winners/professor-william-griffith/#undefined

# OBITUARIES

## Noel G. Coley (1927-2020)

It is with great sadness that we report the passing of Dr Noel Coley, who died on 8 May at the age of ninety-two. He was Chair of the Royal Society of Chemistry's Historical Group from 1994 to 1998 and also Treasurer of the Society for the History of Alchemy and Chemistry from 1982 to 2007. He was thus one of the few people who have held prominent positions in both organisations. A chemist by training and initially a teacher by profession, he took his MSc and PhD in the history of science at Leicester University under William H. Brock. A revised version of his thesis was published in 1973 as *From Animal Chemistry to Biochemistry*. After teaching the history of science at Wolverhampton Technical College, Noel became a staff tutor at the Open University's East Grinstead Regional Centre in the early 1970s soon after the university was set up. He was a member of the OU History of Chemistry Research Group and was a co-author of the Royal Institute of Chemistry's centenary history *Chemists by Profession* with two other members of the group, Colin Russell and Gerrylynn Roberts. He made significant contributions to several OU courses on the history of science and technology and the history of science and belief. Noel was also an accomplished organist. He was universally known for his kindness to others and his courteous manner. He is survived by Awen, his wife, Andrew, his son-in-law, and Jacqui, his granddaughter.

Noel first became involved with the Historical Group in the late 1970s, probably because his colleague Colin Russell was then chair of the group. He helped to organise meetings, especially the group's meetings at the Annual Chemical Congresses which were its main activity for many years. After he became chair of the group in 1994, in succession to John Shorter, the group was suddenly faced with the ending of the Annual Chemical Congresses in 1996. Noel started the process of moving over to a new model of group meetings held twice a year which was continued by his successor Jack Betteridge. The group therefore owes a great debt to Noel for guiding the group through a turbulent period with the minimum of drama and the maximum of tact.

Peter Morris

Jack Betteridge remembers Noel's contribution to the Group at this critical time:

When Noel became Chair, the main activity of the Group was to arrange a session on Historical Chemistry at the Annual Congress of the RSC. There was a meeting of the Group in the afternoon followed by a prestigious lecture in the evening, attended and chaired by the Chair of the RSC. The Historical Group had a high profile in the RSC and the group's sessions, which were well attended, appealed to the chemist who had a broad interest in the history of the subject. Attendance was high. When the RSC decided to forgo the Annual Congress, the Historical Group had to organise a programme for fewer people and with a tighter budget. Noel understood the new workings of the RSC. He led us to understand how the Group could operate successfully as a smaller Subject Group whilst maintaining a broad interest in a wide range of chemical topics. The chemistry was rigorous, but was of interest to both the specialist and non-specialist. That we continue to have well-attended historical sessions today demonstrates the wide-spread interest in the different aspects of our subject. That is no mean achievement, when one compares the actual size of the different branches of chemistry recognised by the RSC. Since his retirement as Chair, Noel gave excellent support to his successors and enthusiastically attended the group's meetings whilst he was able to do so.

Noel's kindness and support of students and colleagues characterised his contributions to the history of chemistry. John Hudson and Anna Simmons worked alongside him in both the Royal Society of Chemistry Historical Group and the Society for the History of Alchemy and Chemistry (SHAC).

John Hudson writes: I owe Noel a great deal. My first contact with him was many years ago when I was trying to find out more about James Keir of the Lunar Society. Then, and on many subsequent occasions, he was extremely helpful. But my main debt to him arose from a conversation we had on a bus stuck in the Edinburgh traffic when travelling from Heriot-Watt University to Waverley Station. I remarked I wished that earlier in life I had studied for a PhD in the history of chemistry. Immediately Noel encouraged me to apply to the Open University and assured me that he would support my application.

Anna Simmons writes: As Treasurer and Secretary of SHAC respectively and committee members of the Historical Group, Noel and I worked together on numerous meetings and society matters. A particular highlight was the joint Anglo-Dutch meeting held at the Museum Boerhaave in Leiden in 2004, the first held by the Historical Group outside Britain and a collaboration with SHAC and the Chemiehistorische Groep van de Koninklijke Nederlandse Chemische Vereniging and the Genootschap Ge WiNa. Noel spoke on "Eighteenth Century Chemical Physicians and the Empirical Art of Medicine" and reported on the meeting and the museum's collections for the *RSCHG Newsletter*.

Noel's deep knowledge of the primary and secondary literature was illustrated in one of his last publications, chapters on "Medical Chemistry and Biochemistry" and "Chemistry before 1800", in Gerrylynn K. Roberts and Colin Russell's *Chemical History: Reviews of the Recent Literature* published by the Royal Society of Chemistry in 2005. The chronological span of his research in the history of chemistry is also reflected in the twenty-five entries, authored or revised for the *Oxford Dictionary of National Biography*. Amongst these there are biographies of the apothecary and chemist Nicolas Le Févre (c.1610-1669), the physician George Fordyce (1736-1802), the chemist Charles Hatchett (1765-1847), the organic chemist Sir Derek Barton (1918-1998) and the biochemist Dorothy Needham (1896-1987).

Noel will be greatly missed by all those who knew him. A memoir by William H. Brock will appear in the August 2020 issue of *Ambix*.

### Kenneth Schofield (1921-2019), FRSC

News of the death in July 2019 of Kenneth Schofield, a long-standing member of the Historical Group, was only received by the Royal Society of Chemistry in April 2020. A Durham University chemistry graduate (BSc and PhD), Ken spent most of his chemical career at the University of Exeter where he was promoted to a professorship in 1974. His principal research interest was in the mechanism of organic nitration and heterocyclic nitrogen compounds, on which subjects he published several monographs. On retirement in the mid-1980s he became interested in the development of mechanistic organic chemistry and compiled a detailed typescript survey, *The Growth of Physical Organic Chemistry* (1996). Compiled like an essay for *Chemical Reviews* with comprehensive citations of primary and secondary literature together with masses of formulae and equations, the book was unpublishable. Curiously, although he presented bound copies of the typescript to a few friends, there is no copy at the University of Exeter, the RSC or the British Library. Fortunately, the typescript generated two extremely useful articles – one on the development of C. K. Ingold's system of organic chemistry, the other on Arthur Lapworth's research – which he published in *Ambix*, 51 (July 1994), 87-107; 52, (November 1995), 160-86. Versions of these papers had been presented at meetings of the Historical Group - the Ingold Centenary meeting at UCL in October 1993, and the RSC's annual meeting at Manchester in 1992. In retirement, until Alzheimer's took hold, he acted as a local JP and witnessed the controversial closure of Exeter's chemistry department in 2005. His two historical articles and unpublished book are outstanding examples of how chemists can contribute to the history of the discipline, particularly its development since 1900.

W. H. Brock

## MEMBERS' PUBLICATIONS

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

Chris Cooksey, "Quirks of Dye Nomenclature 13: Biebrich Scarlet", *Biotechnic & Histochemistry*, published online: 08 Oct 2019.

https://doi.org/10.1080/10520295.2019.1662945

Biebrich scarlet was the first commercial bis-azo dye when it appeared on the market in 1879 in Biebrich on Rhine, Germany. The dye's early history is recounted here with details of the manufacturing process. The possibility that the dye exists in a keto form rather than an enol form is discussed. Application as a textile dye was soon followed by use as a biological stain and for medical applications. Efforts to decolorize the dye to reduce environmental impact are described.

Chris Cooksey, "Quirks of Dye Nomenclature 14: Madder - Queen of Red Dyes", *Biotechnic & Histochemistry*, published online: 05 Feb 2020.

https://doi.org/10.1080/10520295.2020.1714079

The long history of madder as a source of red dyes and pigments is presented. The variety of plant sources and the range of anthraquinone components discovered over a long period are addressed. Topics such as analysis, industrial uses, biological staining, red bone staining in live animals and toxicity are outlined briefly. The contributions of many chemists are acknowledged.

Chris Cooksey, "Quirks of Dye Nomenclature 15: Geranine - A simple name, with a less than straight forward identity", *Biotechnic & Histochemistry*, published online: 28 Apr 2020.

https://doi.org/10.1080/10520295.2020.1744188

Geranines were manufactured initially as textile dyes; they were made by coupling diazotized aromatic amines with sulfonated 1-naphthols. Most commonly encountered was geranine G, which for more than fifty years was thought to be derived from 1-naphthol monosulfonic acid, but later was considered to be derived from a 1-naphthol disulfonic acid. Currently, geranine G is thought to be a mixture of two isomers derived from 1-naphthol disulfonic acids. This species and others are described here by chemical structure and by other reference names and numbers where available. The occasional uses of geranines as biological stains are documented.

## Special Issue of Ambix August 2020

**Chemistry, Consultants and Companies, c. 1830–2000**

Members may also be interested in the special issue of *Ambix* that will be published in August 2020, which contains papers by authors well-known to the Group.

This special issue of *Ambix* brings together five papers presented at the workshop, "The Changing Role of Consultants in Industry, 1850–2000" held at the Maison Française, Oxford, 10-11 May 2019, and now revised in the light of discussions and referees' comments. These papers consider the role of chemists (broadly construed) as consultants in the chemical industry sector of the economy (also broadly construed to include food producers and pharmaceutical companies, among others). These case studies come mainly from Britain, but also from Norway, which provides a useful counterpoint to the British examples and illustrates how consulting for the chemical industry played an important part in nation as well as institution building.

### Consultancy as a Career in Late Nineteenth and Twentieth Century Britain

*Robin Mackie and Gerrylynn Roberts, Open University, UK*

This paper examines the continuing role of consultants within the profession of chemistry in the late nineteenth and twentieth centuries. Consultants were a prominent part of the profession in the late nineteenth century, but were overtaken in numerical terms by chemists working in academia, government and industry in the first half of the twentieth century. The paper demonstrates, however, that numbers later stabilised and then goes on to examine the characteristics of those chemists who worked as consultants as compared to the wider chemical community. It argues that the survival of consultancy is best explained in terms of a number of differing models of consultancy work. Whilst for some chemists, consultancy was their main occupation, for others it was a phase in their careers or a secondary occupation alongside another post. The continuing value of consultancy work was related to its very versatility.

### A Life of "Continuous and Honourable Usefulness": Chemical Consulting and the Career of Robert Warington (1807-1867)

*Anna Simmons, Department of Science and Technology Studies, UCL, UK*

Robert Warington (1807-1867) was a central figure in the mid-nineteenth century chemical community, notably through his role in the foundation of the Chemical Society of London in 1841. As demand for chemical services grew, Warington constructed an ultimately lucrative career in chemistry in which consulting played a major part. His formative years laid ideal foundations for establishing himself as a consultant, whilst his appointment as chemical operator to the Society of Apothecaries' pharmaceutical trade provided the status and infrastructure to sustain this activity. Simmons explores the nature of the chemical services he performed for a range of customers through a survey of his experimental notes. At a time when professional boundaries in the subject were being delineated, this case study provides an example of how chemistry could be commercialised outside the academic environment and how consulting merged into a broader scientific career.

### George E. Davis (1850–1907): Transition from Consultant Chemist to Consultant Chemical Engineer in a Period of Economic Pressure

*Peter Reed, Independent Researcher, USA*

This article explores how George Davis's vision for chemical engineering was contingent upon both the national economic conditions of the period (1870–1900) and the critical transition to more economic production for chemical manufacture. Trade tariffs and international competition exacerbated an already challenging economic climate and stricter government regulation of pollution from chemical manufactories added further pressure. Sectors of the British chemical industry faced over-capacity and over-production, while most sectors were wasteful of materials and energy and were over-manned. Davis's motivation was borne of his work as a chemist, as a consultant and as an inspector with the Alkali Inspectorate, and his search for knowledge and understanding was garnered from ongoing investigations in the field and in his Technical Laboratory, coupled with developments in equipment and machinery. Recognizing his own limited capability to overhaul the British chemical industry, Davis promoted his framework of chemical engineering to increase the cadre of chemical engineers.

### The Chemistry Professor as Consultant at the Norwegian Institute of Technology, 1910–1930

*Annette Lykknes, NTNU-Norwegian University of Science and Technology, Norway*

Norway's first institution of higher technical education, the Norwegian Institute of Technology (NTH), was established in Trondheim in 1910, shortly after the country had gained its independence from Sweden. The establishment of NTH coincided with the beginning of large-scale industry in Norway, and expectations were high as to what the institute could contribute in terms of competence to establish new industries. The professors were expected to be not just teachers or academics, but also to be involved in projects with the industry. Consultancy was one way of exercising authority in relevant areas, and to acquire experience with industrial projects.

It is often stated that the professors at NTH were frequently used as industry consultants, but what this entailed is rarely discussed. In this paper, Lykknes investigates how two chemistry professors, appointed around 1910, formed their roles as consultants: Peder Farup, who experimented with the pigment titanium white for the successful company Elektrokemisk (Elkem) in the 1910s; and Sigval Schmidt-Nielsen, who became the country's authority on nutrition, and served both the state and the margarine industry as a consultant from World War I onwards and into the 1930s. Lykknes argues that both Farup and Schmidt-Nielsen created "hybrid careers", using the concept introduced by Eda Kranaki in 1992.

### Imperial Chemical Industries and Craig Jordan, "The First Tamoxifen Consultant", 1960s-1990s

*Viviane Quirke, Oxford Brookes University, UK*

This paper examines the relationship between Imperial Chemical Industries (ICI), the company which discovered tamoxifen, and Dr Craig Jordan, who played a major part in its success as breast cancer drug, and who worked as a consultant for the company, but without ever being paid a consultancy fee. Instead, ICI funded junior staff working in his laboratory on topics of his choice. They later paid his expenses as an expert witness in patent-litigation cases, as a result of which the US became a major lucrative market for tamoxifen, and ICI's other anti-cancer drugs. This case study illustrates that, like consultants, drugs play an important part at the boundary between the academic and industrial spheres. However, even if it is blurred, the boundary remains. Owing to the secrecy that often surrounds industrial research, it may lead to a different understanding of what constitutes innovation, and to different narratives with regard to respective contributions.

# PUBLICATIONS OF INTEREST

## Business Census of Entrepreneurs

Members may be interested to investigate a remarkable project *The British Business Census of Entrepreneurs* which uses the census data from 1851 – 1911 to identify every business proprietor in England, Wales and Scotland. The project has been a massive undertaking with around 10.5 million entries. Further details, including an *Atlas of Entrepreneurship* can be found here: www.bbce.uk

## The Collected Letters of Sir Humphry Davy

Oxford University Press has just published *The Collected Letters of Sir Humphry Davy*, edited by Tim Fulford and Sharon Ruston with the assistance of Andrew Lacey. Eleven years in the making, this is the first scholarly edition of the correspondence of a man many literary critics know as the friend of Wordsworth, Coleridge, Southey and Scott. He was regarded by Ampere as the greatest chemist ever, having used the Voltaic pile to decompound substances and reveal new elements - including potassium, sodium, chlorine and iodine - demonstrating the forces that hold matter together to be electrochemical. He experimented with nitrous oxide, designed a mine safety lamp, and became the most charismatic lecturer of the era. He knew James Watt, Josiah Wedgwood, Erasmus Darwin, John Dalton, Henry Mackenzie, Henry Cavendish, Joseph Banks, William Godwin, Byron, De Stael, Amelia Opie, Caroline Herschel and Mary Somerville. His proteges were Michael Faraday and John Herschel. He wrote a lot of poetry - mostly landscape verse influenced by his intimate knowledge of Wordsworth's, Southey's and Coleridge's poems. All these facets of a man of science who was widely seen as the embodiment of genius are reflected in the edition, which comprises four volumes including an introduction, comprehensive annotations, biographies of salient people, and a glossary of chemical terms.

The following journal issues have been published since the winter 2020 newsletter was completed.

## *Ambix* – The Journal of the Society for the History of Alchemy and Chemistry

**_Ambix_, February 2020, volume 67, issue 1**

Didier Kahn and Hiro Hirai, "Paracelsus, Forgeries and Transmutation: Introduction" -Open Access.

Urs Leo Gantenbein, "Real or Fake? New Light on the Paracelsian *De Natura rerum*".

William R. Newman, "Bad Chemistry: Basilisks and Women in Paracelsus and pseudo-Paracelsus".

Amadeo Murase, "The Homunculus and the Paracelsian *Liber de imaginibus*".

Andrew Sparling, "Paracelsus: A Transmutational Alchemist".

Urs Leo Gantenbein, "Cross and Crucible: Alchemy in the Theology of Paracelsus".

**_Ambix_, May 2020, volume 67, issue 2**

Linda A. Newson, "Alchemy and Chemical Medicines in Early Colonial Lima, Peru".

Nicola Polloni, "A Matter of Philosophers and Spheres: Medieval Glosses on Artephius's *Key of Wisdom*".

Hilde Norrgrén, "An Alchemist in Greenland: Hans Egede (1686-1758) and Alchemical Practice in the Colony of Hope" - Open Access.

Karoliina Pulkkinen, "Values in the Development of Early Periodic Tables" - Open Access.

## *Bulletin for the History of Chemistry*

**_Bulletin for the History of Chemistry_, 2019, 44 (2)**

David E. Lewis, "1860-1861: Magic Years in the Development of the Structural Theory of Organic Chemistry".

Nathan M. Brooks, "The Kazan School of Chemistry: A Re-interpretation".

Gregory S. Girolami and Vera V. Mainz, "Mendeleev, Meyer, and Atomic Volume: An Introduction to an English Translation of Mendeleev's 1869 Article".

D. I. Mendeleev, translated by Gregory S. Girolami and Vera V. Mainz, "Primary Documents: On the Atomic Volume of Simple Bodies".

Christopher P. Nicholas, "Terpene Transformations and Family Relations: Vladimir Ipatieff".

Seth C. Rasmussen, "Early History of Polyaniline – Revisited: Russian Contributions of Fritzsche and Zinin".

Dean F. Martin and Martwa Elkharsity, "Chemist at War: World War II Roles of Jonas Kamlet, Consulting Chemist".

**Book Reviews**

E. Thomas Strom and Vera V. Mainz, Eds., *The Posthumous Nobel Prize in Chemistry. Volume 2*. Reviewed by Arthur Greenberg.

Jeannette E. Brown, *African American Women Chemists in the Modern Era*. Reviewed by E. Thomas Strom.

Patricia Fara, *A Lab of One's Own: Science and Suffrage in the First World War*. Reviewed by Connie Hendrickson.

Helge Kragh, *From Transuranic to Superheavy Elements: A Story of Dispute and Creation*. Reviewed by Paul J. Karol

Jeffrey I. Seeman, "The Back Story, Koji Nakanishi".

***Bulletin for the History of Chemistry*, 2020, 45 (1)**

Paul Netter, "Jean-Baptiste and Anselme Payen, Chemical Manufacturers in Grenelle Near Paris (1791-1838)".

Charles S. Weinert, "Die Chemie ist Schwierig: Winkler and the Discovery of Germanium".

Arthur Greenberg, "An Old English Pharmacy".

Pierre Laszlo, "Triply Formulated Nitrocellulose: Celluloid, Viscose and Cellophane".

Algirdas Ŝulĉius, "Sergey Teleshov, and Tatiana Miryugina, "Forgotten Contribution of V. N. Ipatieff: Production of Butadiene from Ethanol".

Nenad Raos, "Science and Public Perception: The Miller Experiment".

Kaspar F. Burri and Richard J. Friary, "Liberating R. B. Woodward and the Woodward Research Institute from Error".

**Book Reviews**

Peter Wothers, *Antimony, Gold, and Jupiter's Wolf.* Reviewed by Carmen Giunta.

Annette Lykknes and Brigitte Van Tiggelen eds., *Women in Their Element: Selected Women's Contributions to the Periodic System.* Reviewed by Mary Virginia Orna.

Jeffrey I. Seeman, "The Back Story: Sir Jack Baldwin, FRS".

Back issues of the Bulletin through to 2017 are available open access at http://acshist.scs.illinois.edu/bulletin_open_access/bull-index.php

## SOCIETY NEWS

### Society for the History of Alchemy and Chemistry: The Partington Prize 2020

The Society for the History of Alchemy and Chemistry is delighted to announce that the winner of the 2020 Partington Prize is Dr Mike A. Zuber of the University of Queensland for his article "Alchemical Promise, the Fraud Narrative, and the History of Science from Below: A German Adept's Encounter with Robert Boyle and Ambrose Godfrey".

Dr Mike A. Zuber is a Postdoctoral Research Fellow at the Institute for Advanced Studies at the University of Queensland. He obtained his doctorate with distinction at the University of Amsterdam in 2017 and subsequently received grant funding from the Swiss National Science Foundation for a postdoc project based at the University of Oxford. He has published on the scientific, religious, and intellectual history of the seventeenth century, with particular expertise in German-speaking contexts.

The Society for the History of Alchemy and Chemistry established the Partington Prize in memory of Professor James Riddick Partington, the Society's first Chair. It is awarded every three years for an original and unpublished essay on any aspect of the history of alchemy or chemistry. The prize-winning article will appear in *Ambix* in due course.

### The HIST Award for Outstanding Achievement in the History of Chemistry for 2020

The History of Chemistry Division of the American Chemical Society is proud to present the 2020 HIST Award for Outstanding Achievement in the History of Chemistry to Lawrence M. Principe for "his insightful and ground-breaking studies of the actual laboratory chemistry and its documentary presentation in the seventeenth and eighteenth centuries".

Lawrence (Larry) M. Principe was born in northern New Jersey in 1962. He fell in love with alchemy while studying chemistry at the University of Delaware (B.S. Chemistry, B.A. Liberal Studies, 1983). A "dual approach" to the history of Chemistry has characterized his work ever since. He obtained a Ph.D. in Organic Chemistry from Indiana University in 1988, but his interests in the History and Philosophy of Science motivated him to earn a second Ph.D. at Johns Hopkins University in History of Science, from which he graduated in 1996. His dissertation became the best-selling book: *The Aspiring Adept: Robert Boyle and His Alchemical Quest* (Princeton, 1998).

At Johns Hopkins he progressed through the ranks of the non-tenure track faculty in Chemistry, but when an actual tenure-track position in the History of Science opened, he was chosen in 1997 for a joint-appointment between Chemistry and History of Science. In 2006 he was honoured as the endowed Drew Professor of the Humanities, with Chairs in both Chemistry and the History of Science.

## OTHER NEWS

### Giessen Celebrates (?) the Centenary of the Liebig Museum

All the well-laid plans to celebrate the centenary of the opening of the Liebig Museum in Giessen with a series of events in March 2020 inevitably had to be abandoned because of the Covid-19 pandemic. These plans included both events in the Museum (Liebig's former laboratory building in today's Liebigstrasse) and at the University of Giessen, where local schoolchildren would have learned how Liebig is still with us today ("Liebig lebt"). Following the retirement in 1882 of Liebig's successor, Heinrich Will, chemistry teaching continued at the University of Giessen under the direction of Alexander Naumann until a new chemistry institute was built in 1888. The old buildings dating back to 1818 were then successively used as a Bacteriology Institute and as kitchens and cafeterias for an adjacent hospital. Following the centenary of Liebig's birth in 1903, the psychiatrist Robert Sommer, with financial help from Emanuel Merck, developed plans to turn the laboratory buildings into a museum as a permanent memorial to Liebig. Because of the war and other problems, it was not until 26 March 1920 that the Museum opened its doors to the public.

Despite the abandonment of the celebrations, the event is well commemorated in two publications: (1) a beautifully-illustrated commemorative brochure edited by Eduard Alter, *"Liebig lebt!" 100 Jahre Liebig Museum* (Liebig Museum: Giessen, 2020), Pp. 33, euro 7; and (2) a detailed illustrated history of the museum by Franziska Müller and Christoph Meinel, *Das Liebig Laboratorium – von seinen Anfängen bis in die Gegenwart* (Justus Liebig Gesellschaft: Giessen, 2020), Pp. 173, euro 15. The latter forms the tenth volume of the Liebig-Gesellschaft's occasional *Berichte*. Both publications can be ordered from the Ricker'schen Universitätsbuchhandlung, Ludwigsplatz 12, Giessen 35390. There are additional charges for postage.

William H. Brock

### Science History Institute

The Science History Institute has announced the appointment of David Cole as its new president and CEO. Cole was formerly the executive director of the Hagley Museum and Library in Delaware, a position he held since 2013. He replaces Robert G. W. Anderson, who led the Institute through its 2018 rebranding from the Chemical Heritage Foundation. Cole has a history of creating successful initiatives that combine science, learning, partnerships, and outreach. During his tenure at Hagley he expanded the organization's collections, programs, exhibitions, and community service projects, positioning the institution as a leading centre for the study and interpretation of American business and innovation history.

## SHORT ESSAYS

### Who really invented the Grignard Reaction?

Described as "the most versatile reaction in aliphatic chemistry" [1], the Grignard reaction is now 120 years old. But was the idea Grignard's alone or did it come from his research supervisor?

**The Discovery**

Victor Grignard developed the reaction named after him in 1900 and he was awarded the Nobel Prize for Chemistry in 1910. The origins of this reaction can be traced back to 1757, when a French military apothecary Louis Claude Cadet de Gassicourt distilled a mixture of arsenic (III) oxide and potassium acetate and isolated the first organometallic compound. "Cadet's liquor" was a vile-smelling, spontaneously flammable product and under its alternative name of cacodyl oxide was investigated by Robert Bunsen in the 1840s. It was later shown to be a tetramethyl derivative of arsenic, $[(CH_3)_2As]_2O$. Next in the chronology was Friedrich Wöhler's discovery (1840) of tellurium diethyl. This predated Edward Frankland's work on the zinc dialkyls by eight years, but Frankland is generally considered to be the "father" of this branch of chemistry. In the second half of the nineteenth century, rather in the chemical equivalent of butterfly collecting, numerous other organometallics, mainly alkyl derivatives, were synthesised: antimony (1850); lead (1853); sodium and potassium (1858); magnesium (1859); beryllium (1873) and many more.

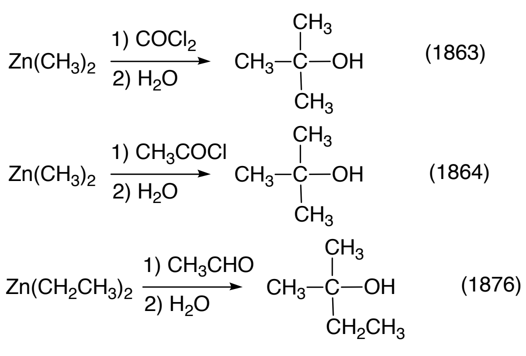


Fig 1 Pre-1900 organometallic routes to alcohols

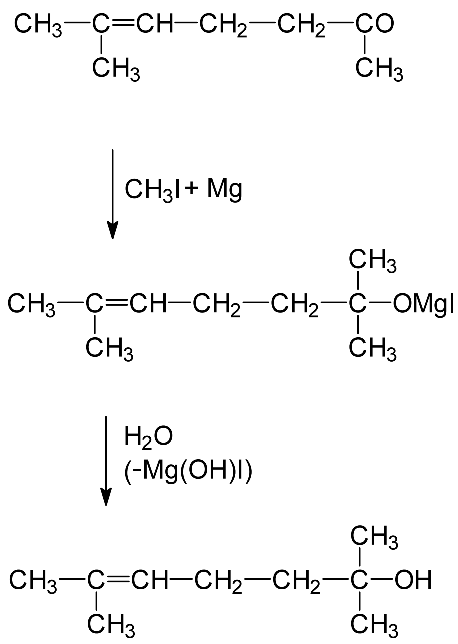
However, Frankland's zinc dialkyls were the only compounds to find much synthetic application in chemistry. Working with these compounds was hazardous as they inflamed spontaneously in air. Paradoxically, although much of their chemistry mimics Grignard's later discoveries (Fig. 1), they are unreactive towards carbon dioxide. Thus, organic acids, easily achieved by the use of Grignard's reagents on $CO_2$, were inaccessible from the zinc dialkyls. To be sure, James Wanklyn, a former pupil of Frankland, prepared sodium propionate in 1858 by the action of carbon dioxide on ethylsodium, made by reacting sodium metal with excess zinc diethyl. However, ethylsodium was too reactive to be very useful as a general synthetic reagent.

Philippe Barbier (1848-1922)
Image courtesy of:
https://en.wikipedia.org/wiki/Philippe_Barbier

In 1898, Phillippe Barbier, head of the Faculty of Sciences at the University of Lyons, was attempting to convert 6-methylhept-5-ene-2-one into 2,6-dimethylhept-5-ene-2-ol (Scheme 1). He could have used zinc dimethyl, but the Russian chemists Alexander Saytzev and Egor Vagner (Wagner) discovered in the early 1870s that secondary alcohols could be prepared from esters using a mixture of zinc metal and alkyl halides. For instance, in 1873, they prepared pentan-3-ol by the action of zinc, ethyl iodide and ethyl formate. Noting this, Barbier tried using a mixture of zinc metal and methyl iodide, but the target compound remained elusive and Barbier decided to replace zinc by the more reactive metal, magnesium. As Barbier decreed that all his papers should be destroyed on his death, we can only speculate on his choice of this metal. Almost certainly he would have been familiar with Mendeleev's horizontal Periodic Table of 1872 which puts together Mg and Zn in the same Group, alongside Ca, Sr, Ba and Hg. We do not know if he attempted (and failed) to achieve a similar reaction with these congeners. Barbier gradually added methyl iodide to a mixture of the ketone, diethyl ether and magnesium turnings, controlling the vigorous reaction by slowing the rate of addition of the methyl iodide. When he decomposed the intermediate complex with dilute sulfuric acid, the desired alcohol was formed. Barbier reported his successful reaction to the French *Academie des Sciences* in 1899, but did not give any yield. He pointed out that his use of magnesium was novel and that it might enable access to compounds which would be difficult or impossible to prepare by existing methods. He therefore reserved the right to exploit his discovery further.

This was typical of Barbier. He was a gruff, rather feared, leader as well as a good chemist. He was apt to get carried away by his many potentially fertile ideas and he would move on to a new aspect of chemistry without having seen a preceding one to maturity. This new reaction was a case in point, and he failed to follow it up. Possibly he was dissatisfied with the reaction because of low yields, or perhaps the chemistry was not as predictable as he first thought.

In late 1899 Victor Grignard, recently appointed chief demonstrator, was seeking a topic for the basis of his doctoral studies. Barbier suggested that he should make a thorough study of his new reaction with a view to its improvement. Grignard decided to carry out the reaction in two steps, *firstly* to prepare the alkyl magnesium halide in anhydrous ether by the action of the alkyl halide on magnesium, *then* react the alkyl magnesium halide (usually in the same flask) with the ketone. This *sequential* procedure is the basis of the classic Grignard reaction. Grignard first published the results of his research in 1900. After crediting Barbier and Saytzev for their contributions to his work, he described the preparation of the organomagnesium intermediate ($CH_3MgI$) and its reaction with ethanal to produce secondary alcohols, and ketones to form tertiary alcohols (Fig. 2). He noted the instability of some alcohols derived from unsaturated carbonyl compounds and their tendency to eliminate water during distillation. Grignard concluded his paper by expressing his intention to continue his work on the new organomagnesium halides.




**Scheme 1**. The first application of organomagnesium compounds in synthetic organic chemistry (Barbier, 1899)

Indeed, over the next three decades, Grignard continued working on his organomagnesium compounds, seeking to increase their applicability (Table 1).

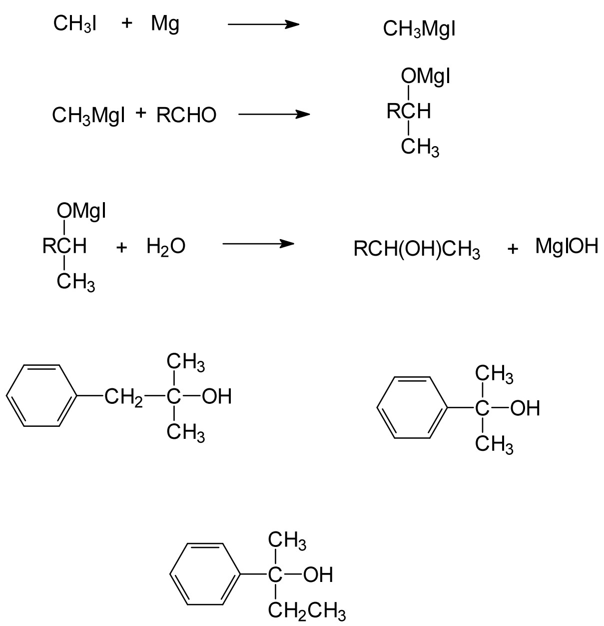
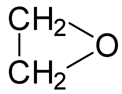
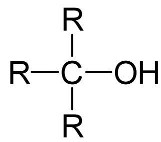
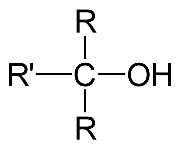
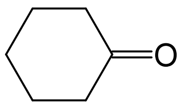
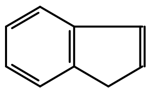
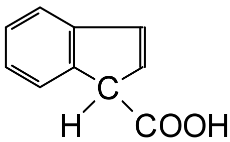
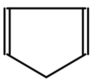
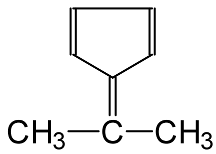


**Fig 2** Grignard's 1900 report of "his" reaction and some of his products achieved as the result of its application

Table 1: Grignard's Later Discoveries using his Reagents

| Date | Substrate attacked by RMgX | Product |
|---|---|---|
| 1901 | $H_2O$ | RH |
| 1903 |  | $RCH_2CH_2OH$ |
| 1903 | $COCl_2$ |  |
| 1903 | COCl<br>\|<br>$CO.OCH_2CH_3$ | $CR_2OMgI$<br>\|<br>$CO.OCH_2CH_3$<br>↓ more substrate<br>$CR_2.OCO.CO_2CH_2CH_3$<br>\|<br>$CO.OCH_2CH_3$ |
| 1904 | R'CO.OMgI |  |
| 1905 | $CH_2Cl$-$CH_2OH$ | $RCH_2CH_2OH$ |
| 1907 | $CO_2$ on<br>$BrMg(CH_2)_5MgBr$ |  |
| 1910 | $SOCl_2$ | $R_2S$=O |
| 1911 | <br>followed by $CO_2$ |  |
| 1911 | Cl—C≡N | R—C≡N |
| 1914 | <br>then $CH_3COCH_3$ |  |
| 1919 | Cl—C≡N<br>then more RMgHal | R.CO.R |
| 1928 | H—C≡C—H<br>excess of RMgI<br>then $CO_2$ | HOOC—C≡C—COOH |

| | | |
|---|---|---|
| 1928 | H—C≡C—H<br>then $CO_2$ | H—C≡C—COOH |

## A Dispute

Possibly realising that a Nobel Prize was in the offing, Barbier sought to stake his own claim on Grignard's method in 1910. This was when Grignard was on the point of leaving Lyons, and whether Grignard left Lyons because he was aware of Barbier's discontent or Barbier delayed his submission until Grignard arrived in Nancy, must remain a moot point. Taking care not to point an accusatory finger at his former collaborator ("M. Grignard, who at all times accorded to me the legitimate part I played in the discovery ......" ) Barbier was clearly aggrieved that the employment of magnesium as an intermediate in the manufacture of alcohols and other substances was attributed by the early twentieth century chemical community to Grignard alone. Using the *Bulletin de la Société Chimique de France* as his vehicle, he recounted his discovery of the chemistry summarised in Scheme 1, and emphasised his innovation of replacing Saytzev's zinc by magnesium. He remarked "from the scientific viewpoint I must consider myself as the originator of the very basis of the reaction". Barbier concluded, though, on a note of compromise: "...In all equity it would be proper henceforth to attach our joint names to this ('Grignard') reaction". This suggests that his main aim was to win a share in any Nobel Prize for the new method.

Grignard replied later that year in the same journal. Using measured and rather saddened tones, he was concerned that readers of Barbier's paper would think that he was to blame for minimising the role of "his revered master" in the discovery. He differentiated between Barbier's "add everything together" procedure and his development of first preparing the organo-magnesium halide in anhydrous ether and then adding the substrate. Even here, however, he gave credit to the earlier observations of Frankland in 1855 and Wanklyn in 1858 that anhydrous ether both promoted the reaction between zinc and alkyl iodides, and further, that the ether somehow stabilised the organometallic compound. Grignard concluded his paper by "accepting credit for the applications of the organomagnesium halides which chemists have paid to me by attaching my name to it".

Victor Grignard (1871-1935)
Image courtesy of:
https://www.buscabiografias.com/biografia/verDetalle/10498/Victor%20Grignard

## Nobel Prize

Two years later, the 1912 Nobel Prize was awarded jointly to Grignard for his organomagnesium researches and to Paul Sabatier for his work on catalytic hydrogenation. The days of multiple awards of the Nobel Prizes had not yet arrived, this was the first time the chemistry prize had been awarded jointly and it was not awarded to three scientists until 1946. This meant that Barbier was overlooked and, perhaps more importantly, so was Sabatier's collaborator in the hydrogenation work, Jean Baptiste Senderens.

## The Last Word

The Grignard reaction remains one of the most important transformations in organic chemistry. In the decade 2009-2019, it featured in just over of 30,000 reports of original research. Perhaps Barbier was rightfully aggrieved that the reaction which first saw the light of day in his hands was attributed to his pupil. But some modern chemists have achieved a compromise. When all the 'Grignard' ingredients are mixed together at the start of the reaction, it is known as the Barbier reaction. This gets an occasional mention in some textbooks, and has been the focus of a recent review. But the credit for the wide exploitation of the organomagnesium halides goes to Victor Grignard, and he, quite justifiably gets a mention in every introductory organic chemistry text.

**Acknowledgements**

We thank Allan Lloyd (University of Derby) for help with some translations from the French literature. Further details of Grignard and his work are available in the obituary notices by Gibson and Pope [2] and Courtot [3]. Barbier's discovery of the use of magnesium as an alternative to the existing organozinc compounds is featured in Heinrich Rheinboldt's article "Fifty years of the Grignard reaction" [4]. Further details about Grignard are available in James' collection of "chemical" biographies [5].

This is a slightly shortened version of an article that appeared in *Education in Chemistry* in 2000 [6]. It is reproduced here with the agreement of the current editor.

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1. G. H. Richter, *Textbook of Organic Chemistry, 3rd edn* (New York: John Wiley & Sons, 1952).

2. C. S. Gibson and W. J. Pope, *J. Chem. Soc.*, 1937, 171.

3. C. Courtot, *Bull. Soc. Chim. France*, 1936, 5, 1433.

4. H. Rheinboldt, *J. Chem. Ed.*, 1950, 27, 467.

5. M. J. Nye in L. K. James ed., *Nobel Laureates in Chemistry, 1901-1992* (Washington, D. C: ACS and CHF Press, 1993).

6. A. T. Dronsfield, P. J. T. Morris and T. M. Brown, *Ed. Chem.*, 2000, 37, 131.

## Additional Note: Victor Grignard - A Short Biography

François Auguste Victor Grignard was born in Cherbourg on 6 May 1871, the son of Théophile Henri Grignard, a master sail-maker at the Marine Arsenal, and his wife Marie Hébert. Grignard's father had trained in the craft of sail-making at a college in Brest, rose to the position of foreman in the arsenal and eventually became a municipal councillor. After being educated at local schools, Grignard in 1889 enrolled at a teacher training college, the *École Normale Spéciale*, at Cluny in Burgundy, with the intention of becoming a mathematics teacher. The college was closed down two years later and its students were transferred to nearby universities, Grignard enrolling in the science faculty at Lyon. Initially, Grignard had an unfavourable view of chemistry, but was won over by his classmate Louis Rousset and worked for a year under Louis Bouveault. Bouveault, who was only seven years older than Grignard, is best known for the Bouveault-Blanc reduction of esters (1903) to the corresponding alcohol with sodium metal and ethanol. Rousset's untimely death in 1898 opened his position of chief demonstrator to Grignard and thereby led to his collaboration with Barbier.

Apart from one year at the University of Besançon (1905-1906) and a decade at the University of Nancy (1909-1919), Grignard spent his entire career at Lyon, turning down at least two offers of a chair in Paris. When the First World War broke out, he volunteered and was initially given the task of guarding a railway bridge in Normandy. Soon, however, Corporal Grignard was transferred to scientific work, and he investigated the manufacture of toluene at Nancy. He then worked with Georges Urbain at the Sorbonne on the analysis and manufacture of chemical weapons. In the winter of 1917-1918, he was sent to the United States to co-ordinate the French production of explosives and war gases with the Americans, and promoted to sub-lieutenant. After his return to Lyons, Grignard was also put in charge of the college of industrial chemistry sponsored by the local chamber of commerce. In the early 1930s, Grignard started to produce a multivolume treatise of organic chemistry, but this was cut short by his death on 13 December 1935. Grignard had never suffered from ill-health, but he underwent an operation after a six-week illness (probably cancer) and never recovered.

After he secured his position at Nancy, Grignard in 1910 married Augustine Marie Boulant, an old friend from his youth in Cherbourg, who had recently become a widow. They had a son, Roger, who became a chemist.

Alan Dronsfield, Peter Morris and (the late) Trevor Brown

## The Birth of Spectroscopy and the Chemistry of the Sun

*The Chemistry of the Sun* is the title of a book on Solar Spectroscopy by J. Norman Lockyer (Later Sir Norman) first published in 1887 [1]. I live in Devon and Lockyer is Devon's 'own' favourite astronomer. He is considered so for reasons I will mention towards the end of this article.

Astronomical and analytical laboratory spectroscopy developed apace in the mid-nineteenth century through the efforts of astronomers, opticians, physicists and chemists. A need to interpret solar and stellar spectra provided laboratory spectroscopy with motivation and impetus, even if its potential in analytical and inorganic chemistry was equally recognised. "This is something like Qualitative Analysis", said the distinguished chemist Henry Roscoe in a letter to G. G. Stokes in 1860. To us, now, pen and ink or photographic records of stellar spectra look like bar-codes, the Victorians saw them in a similar way too, even if they did not know what a bar-code was as such.

Spectroscopy caused a revolution in astronomy and resulted in the birth of astrophysics. Indeed, Norman Lockyer became the first Professor of *Astronomical Physics* at Kensington. Spectroscopy remains the prime method of examining our sun, even if helioseismology and fly-by multi-sensor observation have been added more recently.

Furthermore, substantial controversy remains regarding the integrity and interpretation of spectroscopic data, as I will mention at the end.

I should perhaps preface this informal article by saying that my own interest in the history of spectroscopy and its role in astronomy is purely amateur, dilettante really. I have done no original research, I have merely read several contemporary accounts, plus three or four subsequent histories and biographies. I was curious in the first instance to see what, in particular, the early pioneers made of line spectra as complex as, say, that of iron, in the absence of any understanding of atomic structure. Also, to see how laboratory emission and adsorption spectra were generated (by flame, arc, spark and magnesium lamp) and how light was detected: that was by eye, at first, but not for long, as Lockyer at Kensington was one of the first, if not the first, to use photography in the late 1870s. The photocell was not invented until a quarter of a century later, by Geitel and Elster in 1893, when spectroscopy became truly quantitative.

I hope that the reader will forgive informality of this article. I would not presume with a topic mainstream to most chemists, but rather suspect that early spectroscopy and its astronomical context is not one, and hence my aim is simply to introduce the subject to those unfamiliar with it. My sources are the books listed below and the various web-pages I have provided links to.

*The Chemistry of the Sun* was not the first book on spectroscopy in English. This was a translation of a series of lectures by Gustav Kirchhoff by Henry Roscoe in 1862 [2], which he followed up in 1869 with an illustrated monograph entitled *Spectrum Analysis* [3], based on six lectures of his own given to the Society of Apothecaries in 1868. Shortly thereafter, the Lassell sisters and the astronomer William Huggins translated and edited the second edition of Heinrich Schellen's *Spectrum Analysis,* published in 1872 [4]. The latter's full title was: *Spectrum Analysis - in its applications to terrestrial substances and the physical constitution of heavenly bodies; familiarly explained*.

"Familiarly explained" – this was a hot topic (sic) and Kirchhoff, Schellen, Huggins et al. and Roscoe were all aiming to make the latest research accessible. All four books are readily available in various forms, including online archive and paperback reprint. The originals are well worth viewing, even so, for their fine reproductions of spectra and illustrations of equipment. Roscoe [3] and Schellen et al. [4] in particular, as they contain coloured spectra and have even coloured decorations on their covers. Hardcopies can be found in the libraries of many older institutions and collections. They can still be bought at reasonable prices, too, from time to time. You can see the cover of Roscoe' *Spectrum Analysis* here https://www.lindahall.org/henry-enfield-roscoe/, together with one or two spectra; a very striking photograph of Bunsen, Kirchhoff and Roscoe, together with a photo of Roscoe's and Frankland's joint RSC Blue Plaque. Lockyer's book, has only black and white reproductions of spectra, even if it otherwise contains very fine line drawings of apparatus etc. Lockyer, does however go into some technical detail of what was difficult and painstaking work. In respect of the taking of celestial spectra in particular: Lockyer was no chemist and was doing little of his own laboratory spectroscopy at the time, relying on collaborators, notably William Allen Miller, even if he fully understood the importance of it.

The early British pioneers of astronomical spectroscopy William and Margaret Huggins were introduced to spectroscopy by the chemist, William Allen Miller, mentioned above. They were neighbours in Tulse Hill Road, amongst other things, where Huggins, as its custodian, was to house the Royal Society telescope (in his garden - its lean-to tower rather dominated the house). The older Miller had started working on prismatic spectroscopy in the basement of King's College in the 1840s with the express hope of comparing laboratory flame emission spectra with solar spectra, even though he was confounded in good part by the ubiquity of sodium as an impurity, and the brightness of its lines. He went on to later collaborate with Huggins, then briefly with Lockyer, before such collaboration was rendered impossible by his untimely death at the age of fifty-three. Lockyer then collaborated with yet another eminent chemist, Edward Frankland, briefly, before Frankland (and many others) became exasperated by Lockyer's rather pushy advocacy or promotion of his own work and his tendency to over-interpret or hypothesise (more of which below).

Miller, Roscoe and Huggins brought the work of the German pioneers Kirchhoff and Robert Bunsen, to the attention of a wide audience in Britain. After graduating from UCL, Roscoe worked for Bunsen in Heidelberg, where the photograph taken in 1862 mentioned above was taken.

Let us now back-track to where all this started. Johannes Kepler's finding that sunlight could be split into component colours by means of a prism was not exploited much until the early nineteenth century. The first person to notice that the solar spectrum was not continuous; that it contained lines and gaps was William Wollaston in 1802, who found four to five dark lines, as well bright lines and bands. The dark lines remained a neglected curiosity for a decade or more, until the great optician, Joseph von Fraunhofer, who re-discovered them, became interested in them for optical calibration purposes. He famously went on to develop the diffraction grating, a very fine spectroscope-goniometer, and to make the first high resolution solar spectral maps. In 1814/15 Fraunhofer found not five but over 520 dark lines initially, a number which he increased to over 570 over the next four years or so. His famous 'maps' of the solar spectrum are reproduced widely and can be found online. Finely drawn copies can be found as fold-out pages in Roscoe's first book [2]. Fraunhofer thereafter returned to his optical equipment and it was left to Kirchhoff, Bunsen and others, to identify and assign many of the lines. Their work established a firm foundation which led to the elemental composition of the atmospheres of the sun and selected stars being studied in ever greater detail by Huggins, Lockyer and others as the century went by.

In the early part of the nineteenth century, William Herschel and W. H. F. Talbot exploited flame and spark photometry to identify metals, along with Charles Wheatstone, who added spark to flame. Other early laboratory work included that by Léon Foucault (1849) who observed that certain vapours adsorbed and emitted at the same wavelength, depending upon temperature. Unaware of Foucault's work, A. J. Angstrom found similarly and discovered some of the Balmer lines of hydrogen, as did D. Alter, independently. (You might be forgiven for wondering why they are not called Angstrom-Alter lines, the answer is that Balmer was able to find the numerical relationship between their frequencies). Angstrom and G. G. Stokes are credited with the first attempts to lay down the rules of spectroscopy, it was however Kirchhoff and Bunsen who established unambiguously connection between emission and adsorption. Kirchhoff famously proposed a model of the sun's atmosphere and proposed three laws of spectroscopy building on the earlier work of Angstrom. The three laws can be stated as follows.

An incandescent solid, liquid or gas under high pressure emits a continuous spectrum.

A hot gas under low pressure emits a 'bright-line' or emission-line spectrum.

A continuous spectrum source viewed through a cool, low-density gas produces an absorption-line spectrum.

In the 1860s the husband-and-wife team of William and Margaret Huggins used spectroscopy to show that stars other than the sun had atmospheres composed of elements found on earth and just a few years later Lockyer and Janssen (1868) independently found a third yellow 'D' line, thereby discovering helium. Locker then went on to use spectroscopy to determine whether sunspots were upwellings or sinks (1869); to discover the chromosphere and with others, to develop a much more detailed picture of the sun's atmosphere and its composition.

That is as much as I plan to say about the history of astronomical spectroscopy in general, so let me now return to my question regarding the cause of lines in atomic spectra.

Most involved seem to have been atomists, even if many physicists of the day were not. Hence it was taken as a given in the field that the lines were a signature of atomic vibrations of some sort, with most leaving it that, with the notable exception of Norman Lockyer. Lockyer, who was inclined to believe in the unity of knowledge and of nature, was rather prone to develop overarching hypotheses and to look for evidence to support them. One such hypothesis was his *Dissociation Hypothesis*, which *inter alia* aimed to explain the many lines [4,5]. We now know that even the spectrum of hydrogen contains a large number of lines, but Lockyer did not, then at least, as it has very few in the visible and near UV (which could be accessed by Lockyer using photography). Hence, to him, the spectrum of hydrogen would have looked rather simple, whereas heavier atoms like iron, which has many lines in the visible, did not. He said (in a BA report in 1882):

> The spectrum of iron … presents thousands of lines through the whole length of the visible and UV* … It would seem hard to conceive any single 'molecule' [sic] to be capable of all of them, and are almost driven to ascribe them to a mixture of differing 'molecules', though we have no independent evidence of this.

His idea was that, whereas hydrogen might well be primal, or, immutable, the heavier atoms were composites or 'molecules' which broke down into ever smaller atoms as the temperature was raised. He was drawing an analogy with the pyrolysis of larger organic molecules, in a sense. It was not an unreasonable hypothesis, arguably, and Lockyer spent years looking for evidence of it in the spectra. He clung to it for far too long, though, in the face of growing evidence that spectra of small and larger atoms were not related in the manner implied. Indeed, he became distanced from other astronomers and from chemists like Edward Frankland as a result. Lockyer, however, had quite a lot riding on his Dissociation Hypothesis as it became in time part of a larger scheme. It connected with another of his ideas, that of *Inorganic Evolution*, the converse idea that bigger, more complex atoms might have 'evolved' from smaller ones. Lockyer knew Huxley well and was much taken with the Theory of Evolution, which influenced his thinking in this regard. Another of his books addresses that idea [6].

He hypothesised on star formation too in yet another volume. In the absence of any knowledge of radioactivity or of atomic fusion, he was obliged to suppose that stars, and for that matter the earth's interior, had been heated by the gravitational energy released upon their formation (even if the energy accounting don't work, as others quickly realised). The observation that meteorite samples have a similar elemental composition to the earth, and to (the atmospheres of) the stars and sun, led Lockyer to propose yet another scheme, the *Meteoric Hypothesis*, which asserted that *meteorites* were the primal objects of cosmology from which stars and planet formed. *The Meteoric Hypothesis* is the title of another of Lockyer's monographs for MacMillan based on his spectroscopic work [7].

Today, Lockyer is widely remembered as the founding editor of *Nature*, the first edition of which appeared on Thursday 4 November 1869, published by MacMillan. In 2008, in anticipation of that journal's 150$^{th}$ anniversary, MacMillan produced a second edition of A. J. Meadows' (1972) biography of Lockyer - *Science and Controversy* [8]. The scope is wide-ranging, as befits its subject, who enjoyed a long, distinguished and varied career as a civil servant, astronomer, meteorologist, archaeologist [9], journalist and author, science policy maker and public figure. It might, thus, perhaps, not be the first choice of book for those interested solely in history of astrophysics or spectroscopy, even though the science is dealt with authoritatively and by a professional astronomer, as it takes up less than half the book. Many will however be interested too in the other matters addressed, such as the development of public policy in science and the early days of *Nature*.

The "controversy" in the title refers, in part to the results of Lockyer's hypothesising and advocacy of his own work, in part to his views on the organisation and funding of teaching and research, and to his use of the editorial chair of *Nature* as a bit of a bully-pulpit for his views. Lockyer was evidently a genial, civilised, gregarious and sociable man, except that that did not seem to prevent him from trying the scientific community sore at times. J. C. Maxwell, who was fond of aiming such rhymes as fellow scientists, wrote of Lockyer:

And Lockyer, and Lockyer,
Gets cockier and cockier,
For he thinks he's the owner,
Of the solar corona'.

It seems, though, that Huggins was even less popular, public and scientific acclaim and many honours, not withstanding, if remarks by friends such as Crookes are anything go by. I shall spare you the remark I have in mind, it can be found in the next book I am going to mention, except to say that, coming from a friend, as it does, it caused me to wonder what on earth his enemies might have said about him. I should perhaps add in fairness to Huggins, though, that these astronomical gents had plenty of opportunity to irritate each other as they were given to sailing off together in cramped ships to study eclipses in far-flung places.

An excellent alternative to *Science and Controversy* would be Barbara Becker's *Unravelling Starlight* [9], an award-winning (2011) account of the birth of astrophysics and the role of the husband and wife team of Sir William and Lady Huggins in that story. It was the elder Huggins who suggested Lockyer consider bolting a spectroscope to his telescope in the first place (a barrister neighbour had introduced Lockyer to observational astronomy just a few years earlier). Lockyer was studying the planets at the time, and it was almost certainly not Huggins' idea that Lockyer should apply spectroscopy to the sun, as he went on to do, since Huggins saw the sun as his own next priority. Like *Science and Controversy*, *Unravelling Starlight* is a biography of one of the great British pioneers of astro-spectroscopy, except that it can be equally well read as a history of the field in that period (and up to the turn of the century), and I would recommend it as the place to start for anyone interest to find out more. I found it to be a most entertaining read, as well as interesting and informative.

I have not yet mentioned the first biography of Lockyer [11]. I read it before Meadow's *Science & Controversy*, but would not have done in hindsight, as it is much less comprehensive in several regards. It is a very different book, inevitably, being written by his daughters, fifty years earlier, but very good on his background.

My reading up to that point having given me an idea how spectra were used and interpreted prior to the quantum revolution, I decided to finish my little enquiry by asking how they were analysed thereafter [12]. The book that chose itself was Rosseland's *Theoretical Astrophysics* of 1936 [13], a volume intended be the first of a two-part treatise on the new astrophysics, except that the second part, on GR and cosmology, was never completed, sadly.

It was fascinating to see just how much progress had been made in applying quantum mechanics (QM) in less than a decade, given that the book runs to around 350 pages and deals with nothing much else but the interpretation of spectra using QM. I bought my own copy, as I am interested both in astrophysics and in the foundations and history of quantum mechanics. For those who are not, 350-odd pages might be a little too much, perhaps, except that several libraries have copies available to view, including the Royal Institution, for those who visit London [14]. For what it is worth, let me mention that I found reading Rosseland rather like reading J. W. Gibbs in the original; one is quickly and firmly reminded of one's place in the scientific hierarchy of ability.

Coming up to the present now, it is, for those who model the sun, vital to account for the presence of heavier trace elements, since these moderate the fusion reactions by influencing heat transport. The concentrations of various metals inside the sun are estimated from their distributions in solar atmosphere as determined by spectroscopy. There is however disagreement between older and newer spectroscopic data in certain regards. Somewhat ironically, calculations of the energy output (etc.) of the sun based on older data agree better with measurements than calculations based on new spectral work. The difference is approximately twenty-five percent. This problem is known as the *Solar Abundance Problem*: https://core.ac.uk/display/25010081

Penultimately, let me explain why Lockyer is well-known in Devon. Lockyer, many years a widower, married again late in life, to a suffragist widow named Mary Thomasina Brodhurst (née Browne), who owned substantial property in East Devon. When he retired as Director of the Solar Observatory in 1913, they went down to her estate in Salcombe Regis near Sidmouth where, with the help of generous donations from friends he set up a new observatory. Originally known as the Hill Observatory, the site was renamed the Norman Lockyer Observatory after his death, when it was directed by his fifth son, William J. S. Lockyer. For a time, the observatory was a part of the University of Exeter, but is now owned by the East Devon District Council, and run by the Norman Lockyer Observatory Society. It opens to the public on selected evenings and is well worth a visit, should you find yourself in the area. New visitors are often very surprised at its scope and scale (its buildings occupy ca. 1 hectare) and, whereas the telescopes may be old, they are good ones and still used for serious work. The Observatory now houses a second-hand Planetarium too: https://normanlockyer.com.

Let me repeat the one of Lockyer's concluding statements from *Chemistry of the Sun* where he bemoans the fact that laboratory work had yet to show direct evidence of the atomic *Dissociation* he claimed to see evidence of in his solar spectra.

> …if the elementary bodies [i.e. atoms] are incapable of separation into their constituents by ordinary chemical processes, and yet are decomposable, the spectra in this book are those which would be expected if high temperatures dissociate. This evidence is not to be neglected because the chemist is slack in producing 'independent' evidence… .

There we are, then, the poor old chemist was holding things up! 'Slack' seems a little harsh to us perhaps, although it is possible that Lockyer did not quite mean it in the way it reads, more likely it just rather puzzled him that more chemists were not dropping their own work and queueing up to collaborate with him on *Dissociation*. Nevertheless, we see in hindsight that he was asking the chemists to split the atom in effect! Lockyer, who died in 1920, lived just long enough to see that happen. He also saw the idea of ionisation develop towards the end of his career, when he did let go of some of his theoretical proposals, in the face of evidence and valid criticism. He was however a great astronomer and experimental astrophysicist who made many discoveries and who created inter alia large collection of spectra of lasting importance (now kept in Cambridge). That work stands, even if some of his interpretative schemes have passed away.

### References


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2. G. Kirchhoff, trans. Henry E. Roscoe, *Researches on the Solar Spectrum and the Spectra of the Chemical Elements* (Cambridge: Macmillan, 1862-63).
3. Henry E. Roscoe, *Spectrum Analysis: Six Lectures, delivered in 1868 before the Society of Apothecaries of London* (London: Macmillan, 1869).

   **Note**: I was not fully aware of the publication history of Roscoe's *Spectrum Analysis,* having just read the first edition, however, Anna Simmons tells me that a second edition appeared in 1870, a third in 1873 and a fourth in 1885. The fourth edition was revised and considerably enlarged to 452 pages by the author and the physicist Sir Arthur Schuster (1851-1934). Schuster had studied under Roscoe at Owens College, Manchester and became Professor of Applied Mathematics there in 1881.
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11. T. Mary Lockyer and Winifred L. Lockyer, with the assistance of Prof. H. Dingle and contributions by Dr. Charles E. St. John [et al]., *Life and Work of Sir Norman Lockyer* (London: Macmillan and Co., 1928).
12. https://en.wikipedia.org/wiki/History_of_spectroscopy.
13. S. Rosseland, *Theoretical Astrophysics* (Oxford: Clarendon Press, 1936).
14. The following is true: I was sitting in the audience at a meeting of this group at the Royal Institution when I noticed a copy of Rosseland on the window alcove bookshelf next to me.


Richard Buscall

## The Chemists' War: IUPAC and SCI – A Lecture to the SCI London Group, December 2019

In a lecture to the RSC Historical Group in March 2019 to celebrate the one hundredth anniversary of IUPAC I summarized the background on how, over many years, the idea for IUPAC developed. I was particularly fascinated by how its development was frustrated by the First World War, and I subsequently expanded this lecture to document what happened around World War I, often called the Chemists' War and presented this new lecture as the SCI London Group Christmas Lecture in December 2019.

IUPAC is all about standards, but over one hundred years before IUPAC was founded in 1919 chemists were already concerned about such things, and they did not always agree. After Dalton's Atomic Theory (1803), Avogadro's Hypothesis (1811) proposed that the number of molecules is directly proportional to volume of gases, but, due to the explanatory power of Berzelius' electrochemical theory, Avogadro's Hypothesis had no influence on the calculation of atomic weights at this time. Berzelius argued that diatomic molecules such as $H_2$ and $O_2$ were impossible because the atoms would repel each other. Fifty years later chemistry remained in a state of disarray. Most chemists believed in atoms and molecules but nobody could agree on molecular formulas. Was water HO or $H_2O$ or $H_2O_2$? Was oxygen's atomic weight 8 or 16, and carbon's 6 or 12?

In 1860 a conference was organised in Karlsruhe by Auguste Kekulé to try and establish definitions for atoms, molecules, equivalence, atomicity, basicity, formulas and nomenclature. Given the slow communication and travel available in 1860 this was an incredible achievement. In the three-month period from his sending invitations, 140 delegates, all well-known chemists from around Europe attended.

Discussion was dominated by voices from the Berzelius faction and the organisers were concerned that the conference was going to be a complete failure. However, one of the final papers was presented by an unknown Italian chemist named Stanislao Cannizzaro. He argued for Avogadro's perspective on molecules and one of his friends handed out a paper that effectively reiterated his speech. Several important delegates read this on their trips home. The speech made the right impact and over the next decade scientists worked out the correct molecular weights and the periodic table. Chemists continued to discuss standardisation in the following twenty years with six more international conferences: 1867 in Paris, 1872 in Moscow, 1873 in Vienna, 1876 in Philadelphia, 1878 in Paris, and 1880 in Düsseldorf. For organic nomenclature, significant progress and agreement was made at a conference in Geneva (1892) organised by Baeyer.

Just before World War I significant progress on agreement between chemists on the issues of standards came closer with the proposal in 1911 by the Société Chimique de France, supported by the Chemical Societies of Great Britain and Germany, to establish the International Association of Chemical Societies (IACS), the forerunner of IUPAC. With further meetings in 1912 and 1913 and, with financial support from the Belgium entrepreneur Ernest Solvay, agreement was being made on the need for standardization, be it the size of publications, matters of notation, standard atomic weights, and chemical formulas.

Then in August 1914 World War I began with the invasion of Belgium. In those early months 6,000 Belgians were killed, 17,700 died during expulsion and 120,000 became forced laborers. These actions by the German army were elsewhere called the 'Rape of Belgium'. In response, ninety-three prominent German intellectuals signed a manifesto appealing to the 'civilized world' to recognize Germany's war effort as a noble case of self-defence reluctantly undertaken. The names who signed included many prominent German chemists, Haber, Baeyer, Fischer, Nernst, Fischer, and Willstätter. It aroused indignation on the part of the allies that never subsided, leading to Germany being excluded from taking part in the IACS and subsequent cooperation. IACS gave the money back to Solvay and disbanded the short-lived dream of international chemical collaboration.

Very soon the use of chemical weapons demonstrated the power of the German chemical industry. It is widely thought that gas was first used as a weapon in World War I by Germany, but tear gas grenades were first used by the French in August 1914, followed by Germany in early 1915. These contained xylyl bromide, or ethyl bromoacetate. As lachrymatory agents, they irritate the eyes and cause uncontrolled tearing. If inhaled they also make breathing difficult, but symptoms usually resolve by thirty minutes after contact, so tear gas was never very effective as a weapon against groups of enemy soldiers.

A key person in the war gas story is the German chemist, Fritz Haber. Assisted by Robert Le Rossignol, he developed the Haber process for the fixation of nitrogen from air. Working with Carl Bosch at BASF, the process was scaled up to produce large-scale quantities of ammonia and hence synthetic nitrates. These were critical in fertiliser production and enabled Germany to feed its population during World War I when the Allies' blockage of German ports cut of the supply of nitrates from South America. Haber's discovery also enabled production of the vast quantities of nitrate-based explosives needed for front line use.

Haber was a loyal German patriot, and had earlier converted from Judaism to Christianity to improve his prospects. At the start of World War I he was rewarded with an army captaincy and made head of the Chemistry Section at the Ministry of War in Berlin. Although the large-scale use of chemical weapons was banned under the Hague Convention of 1907, he set to work on what he termed a "higher form of killing". He recognized that chlorine gas, which reacts with water in the airways to produce tissue-corroding hydrochloric acid, was the rough and ready option. It was easy to produce and handle so could be quickly shipped to the front. The first major gas attack by the German army was at Ypres on 22 April 1915. They released more than 168 tons of chlorine gas from nearly 6,000 canisters at sunrise on 22 April. Plans were made by Haber who personally supervised the release.

As the war continued Haber's Chemical Warfare Group continued development of more effective war gases. Phosgene was much more effective and deadly than chlorine, the symptoms could sometimes take up to forty-eight hours to manifest. Immediate effects are coughing, and irritation to the eyes and respiratory tract. Subsequently, it can cause the build-up of fluid in the lungs, leading to death. It is estimated that as many as eighty-five percent of the 91,000 deaths attributed to gas in World War I were a result of phosgene or the similar agent diphosgene. Haber continued to be personally involved in developing and supporting the deployment of phosgene and mixtures of chlorine and phosgene. The most notorious gas development by Haber's group was mustard gas (Bis(2-chloroethyl) sulfide), first used by Germany in July 1917 and delivered in artillery shells. It is a vesicant that produced large blisters on any area of contact. Severe blisters emerged when uniforms were soaked in mustard gas. If exposure was high enough, mustard gas could cause permanent eye damage.

Following the early gas attack at Ypres the Allies moved quickly to respond. The resources of existing chemical companies were diverted to gas production, and the British War Office established a 5,500 strong Special Brigade, using chemists from Universities to deal with gas production and handling. One of the principal leaders in this work was Prof. William Pope from Cambridge. He was a keen advocate of use of Chemical Weapons, and worked on phosgene, arsenicals, and most notably a new process for manufacturing mustard gas.

From early in the war considerable effort was being made on protection from gases. At Imperial College Prof. H. Brereton Baker worked on the analysis of poison gases used by Germany and absorbents for gasses and respirators, work which led to the design of the respirator used by the British army. The canisters in early masks used activated charcoal, but very soon other chemicals were added to absorb or destroy a variety of gases. These included soda lime, sodium or potassium permanganate. In Germany Haber's group also worked on gas masks.

Over the four-year war total gas production from both sides was: Chlorine (93,500 tonnes), Phosgene (36,600 tonnes), Diphosgene (11,600 tonnes) and Mustard Gas (11,000 tonnes). War gases resulted in around 1.5 million casualties on both sides, less than one percent were fatal.

The Chemists' War was not just about gas. There were many other chemicals that were a vital part of the war activities. An unusual example is whale oil. This was used to treat the trench foot suffering of soldiers, but was in even greater demand as a raw material for propellants and explosives, it being used for the manufacture of nitro-glycerine. For the manufacture of the propellant Cordite, large quantities of the solvent acetone were needed. Traditionally made by distillation of wood, the yields were low. As the war progressed new methods were sought, and finally a new process was developed by chemists at the Lister Institute. By the end of the war 3000 tonnes per year were produced by the fermentation of maize and rice.

The manufacture of metals and alloys all depended on chemical processes, e.g. the Brodie helmet issued to British troops was based on a new alloy of steel with manganese.

The sick and injured required a whole range of medicinal chemicals, and for this area the list is endless. Perhaps less well known is the problem of drugs during the First World War. Some department stores, including Harrods, sold kits containing syringes, needles and tubes of cocaine and heroin. It was promoted as a present for friends on the frontline – shoot up to make life in the trenches more bearable and alleviate the horrors of war. Burroughs Wellcome sold a cocaine tablet called "Forced March" under their brand name Tabloid, advertised to "allays hunger and prolongs the power of endurance". The recommended dosage was one tablet "to be dissolved in the mouth every hour when undergoing continued mental strain or physical exertion".

As the end of the war came closer, industrial chemists recognized the need to improve the role of the chemical industry after the distressing role of chemistry in what was called the Chemists' War. Chemical societies from France, Britain, Belgium, Italy, and the USA saw the need to formalise and establish an enduring association for cooperation on important aspects of chemical sciences, but crucially Germany was to be excluded. In 1917 an initiative by the Société Chimique de France (SCF) saw the founding of the Société de Chimie Industrielle (SCI - France), modelled on Britain's Society of Chemical Industry. The objectives of SCI-France were to unite all professionals belonging to the chemical industry, to promote the chemical industry's public image, to maintain ongoing relations with learned societies at home and overseas and to aim to set up a new international union of chemistry. Around the time of armistice in October 1918 the Royal Society in London hosted the Inter-allied Conference of Scientific Academies to plan for a new organisation. In the following months considerable progress was made with the SCI (France) and SCI (Britain) to emerge as the main driving force. Meetings in Paris, London and Brussels in April to July 1919 saw the pre-war IACS dissolved and the International Research Council announcing the formation of a new International Association of Pure and Applied Chemistry (IUPAC).

It is significant to finish with what happened to Fritz Haber, who with his 1911 nitrogen fixation process prevented many from starving, but then developed chemical gases that would kill many. Despite his work on war gases, Haber was awarded the 1918 Nobel Prize for Chemistry (received in 1919). Not everyone agreed with the decision. It has been reported that the physicist Ernest Rutherford refused to shake Haber's hand at the Nobel Prize Award ceremony. In the 1920s Haber worked on the recovery of gold from sea water, hoping to enable Germany to meet her war reparations. By 1931, Haber was particularly concerned about the rise of the Nazi Party in Germany. Refusing to fire Jewish scientists at the Kaiser Wilhelm Institute, of which he was head, Haber resigned in 1933 and left Germany. He was invited to work in Cambridge by Sir William Pope. After several months he left Cambridge, but in poor health. He died of a heart attack in Basel, Switzerland, whilst en-route to Israel to become head of Weizmann Institute

### Further Reading


Roger Fennell, *History of IUPAC 1919-1987* (Oxford: Blackwell Science, 1994).

Danielle M.E. Fauque, "French Chemists and the International Reorganisation of chemistry after World War I", *Ambix*, 2011, **58**, 116-135.

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Fred Parrett

## Mendeleev and Great Britain

This article looks at links between the creator of the Periodic System and Great Britain, and brings together less well-known snippets of information which I have uncovered in the course of my research.

### Early Days

17 February 1869 (O.S) is often today recognised as the date of first compilation of the periodic system, to use Mendeleev's words followed by another, more detailed version, in 1871. The chemistry world at that time did not realise its importance. The first English language mention of Mendeleev and the periodic table was about nine months

after his original article. At the 2019 exhibition in Cambridge, Peter Wothers highlighted that it appeared in the Notices Section from Foreign Sources in *Chemical News,* immediately preceded by news about Borodin. Doubtless Mendeleev wished to spread the information, although initially that appears unsuccessful [1].

Meanwhile Mendeleev was investigating the limitation of Boyle-Mariotte's Law, particularly when gases are at very high pressure. His conclusions appeared in an article in *Nature,* a journal he often published in. Thus surprisingly, it appears that his first full article in English was not about the periodic system [2].

Two key dates are directly linked to the periodic system's acceptance. In 1875 Paul-Émile Lecoq de Boisbaudran's discovery of gallium and Mendeleev's claim that this was his predicted element *eka*-silicon made chemists recognise the definite possibility of Mendeleev's ideas. Proof of prediction was particularly persuasive. This was further supported by Lars Fredrik Nilson's discovery of scandium in early 1879. Mendeleev realised that dissemination in an English language periodical would rapidly spread knowledge of his system and enhance his reputation. William Crookes, the subject of the RSC Historical Group's October 2019 meeting, owned and edited *The Chemical News*. In the winter of 1879 to 1880 articles about the periodic table featured in seventeen successive issues [3]. Parts resemble his articles in other publications. Mendeleev and his periodic law were now recognised in England. Invitations to speak or write soon followed.

### Recognition by Learned Scientific Societies

A second consequence of the increasing acceptance of the periodic law was the award by the Royal Society of its Davy Medal jointly to Mendeleev and Lothar Meyer, who is considered by many as co-discoverer of the periodic law. Part of the President's Anniversary address (30 November 1882) is:

> The labours of Mendeleeff and Lothar Meyer have generalised and extended our knowledge of those relations, and have laid the foundation of a general system of classification of the elements. .... Such periodic re-appearance of analogous properties in the series of the elements has been graphically illustrated in a very striking manner with respect to their physical properties such as melting points and atomic volumes. [4]

A decade later the Royal Society deemed Mendeleev "distinguished for his development of the law of periodicity and for his researches in physical chemistry .... as a proper person to be placed its list of Foreign Members" [5]. Strangely it was long after winning the Davy Medal.

When in November 1904 nominations were sought for the next Copley Medal, the Royal Society's oldest and most prestigious award, Mendeleev was nominated by Irish physicist Joseph Larmor and Scottish geologist Archibald Geikie. The other nominee was proposed by two chemists. Nevertheless, Mendeleev was chosen. A great honour to a septuagenarian who might never to return to Britain [6].

Royal Society President Sir William Huggins presented the award to Mendeleev with the citation "For his contribution to chemical and physical sciences". Quoting Thomas Edward Thorpe, Huggins noted that "His 'Principles of Chemistry', published in 1889, and repeatedly reprinted, is a veritable treasure-house of ideas, from which investigators have constantly borrowed ideas for new lines of research. This book is one of the classics of chemistry" [7].

The Chemical Society of London, founded in 1841, was the one the forerunner societies of the RSC. The *Proceedings of the Chemical Society* record that in February 1883 Mendeleev, along with Lothar Meyer and Per Cleve, were elected Honorary Members and were to receive its *Proceedings*. The Faraday Lecture is the most prestigious award of the Chemical Society and its successors. Mendeleev was chosen to give the 1889 lecture, which was delivered at the Royal Institution [8]. The schedule was for Mendeleev to write in Russian then on Friday for James Dewar to read the translated script. The translator was paid £16 according to handwritten Council minutes found in the Society vaults! After a weekend visiting chemists including Ludwig Mond and William Ramsay, Mendeleev was to give the Lecture on Tuesday 4 June. However, having heard that his twin son was ill, he returned home. The Chemical Society's Secretary, Henry Armstrong read the prepared script, then its President, William J. Russell, presented the Faraday Medal and gifts to Mr John Anderson, a fluent Russian speaker, to take back to Mendeleev. The gifts included some gold sovereigns and a pair of aluminium/silver goblets inscribed DIM and AIM (for his wife Anna) [9].

In February 1891, Mendeleev, in his role as President of Russian Physico-Chemical Society (RP-CS), sent most heartfelt congratulations to its oldest brother society the Chemical Society to celebrate the fiftieth anniversary of its foundation. Two years later, the Chemical Society returned greetings to mark the twenty-fifth anniversary of the RP-CS. Referring personally to Mendeleev, it was noted that "It is proud to have enrolled your name on the list of foreign members and to have welcomed you as a Faraday lecturer" [10].

The Royal Philosophical Society of Glasgow is a learned society established in 1802 for the improvement of the arts and sciences in the city. In 1860 its honorary membership was limited to twenty people: "distinguished men of science belonging to any part of the world". On 6 April 1904 the Society unanimously elected Mendeleev to honorary membership. Society Secretary Freeland Fergus wrote the invitation to Professor Ivanovilach Mendeleev, D. Phil. [11].

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Photograph: Courtesy of the John Rylands Library, University of Manchester.

The British Association for the Advancement of Science Meeting took place in Manchester in 1887. Mendeleev spoke on “The Combination of Water and Alcohol”, which would link with his St Petersburg Doctor of Science thesis of 1865 of the same title. The photograph above shows local and overseas professors at the meeting. The front row shows Henry Roscoe (Manchester), Mendeleev and Carl Schorlemmer.

## Honorary University Degrees

Mendeleev’s first professional visit to Great Britain was to Edinburgh University, which celebrated its Tercentenary with a special week in April 1884. It was a huge occasion to which a galaxy of 126 academics, across all subjects, were invited. Fifty-three men were particularly marked out through the bestowal of honorary degrees. Mendeleev received an LLD (Doctor of Law), being described in the honorands list as the writer of a chemistry textbook, author of many papers on absolute boiling point (critical temperature), the Periodic Law of the Chemical Elements and other chemical and physical subjects. In 1905 Russian artist Ilya Repin painted Mendeleev, reading a book, seated in his sky-blue and red Edinburgh doctoral robes, which I believe is the only true colour portrait. The quality of attendees in Edinburgh is illustrated by the choice of British physical scientists: John Strutt (Lord Rayleigh), William Thomson (Lord Kelvin), Gabriel George Stokes (Cambridge), Edward Williamson (Manchester, ether synthesis), and local organic chemistry professor Alexander Crum-Brown, at whose house Mendeleev stayed. German physicist Hermann Helmholtz is the only European name I recognised, other than Mendeleev’s. The second main function was a formal luncheon for 200 people. Mendeleev’s growing global recognition is suggested from his position on the top table [12].

It was a decade later before England’s oldest universities Oxford and Cambridge honoured Mendeleev, through the annually held *Encœniae*, special degree ceremonies delivered entirely in Latin to bestow honorary degrees. Mendeleev first went to Oxford where on 20 June 1894 he received an honorary DCL, but enquiries to the university archivist yielded no further details. A week later Mendeleev was at Cambridge University for its *Encœnia* for which several pages of detail are given in the official university publication. Two sentences, about a quarter of the Latin text, follow with a translation by a classics colleague with no scientific background.

> *Magnum profecto est inter tot elementa rationem certis intervallis velut circuitu quodam recurrentem observasse, eque rerum notarum observatione etiam ignota providisse. ... Quae elementa, trium gentium insignium nominibus Gallium, Scandium, Germanium noncupata, nomen ipsius illustrius reddiderunt et Russorum famam, quantum ad ipsum attinet, feliciter auxerunt).* [13]
>
> It is indeed a great thing to have discovered among so many elements a relationship occurring at fixed intervals, as if periodically, and from observation of the known to have also forecast the unknown. ... These elements named after famous nations Gallium, Scandium and Germanium have rendered his name more illustrious, and insofar as it relates to him, the reputation of the Russians.

The full text only deals with periodicity unlike some other honours and it is striking how much of the English text after two translations still identifies Mendeleev's genius. The full text and its translation are available from the author at gandp16@talktalk.net.

### Two Great Chemists Clash

In 1894, from a detailed series of experiments, British chemist William Ramsay concluded that in atmospheric nitrogen there was an 'impurity' of molecular weight about 40. What was it? There was no space between the halogens and the alkali metals. This was a perplexing problem for chemists, but particularly for Mendeleev for whom the similarity of properties within a group was unquestionable.

Mendeleev considered various atomicities to determine the atomic weight and hence its periodic table position.

O (16) F (19) Na (23) Mg (24) If A was diatomic like other gaseous elements.

S (32) Cl (35.5) K (39) Ca (40) If A was monatomic.

Mendeleev thought the most likely explanation was an unusual molecule of nitrogen ($N_3$) with molecular weight forty-two, but again there was no available space [14]. Mendeleev considered the problem of such importance that he came to London in 1895 to discuss it with Ramsay. Ramsay brilliantly suggested that if there were a space, there would be a whole group of similar gases. Mendeleev gradually changed his point of view as more gases with similar properties were discovered. Indeed, he said it was a further example of his periodic law!

### How Often did Mendeleev Visit Great Britain?

Mendeleev travelled extensively, assisted by various foreign contacts who invited him to their own countries and also by the accessibility of travel by both ship and train from St Petersburg. Within Britain his first professional visit was to Scotland and the remainder to England.

1862: From correspondence with Professor Eugene Babaev of Moscow State University, I learnt that Mendeleev on his honeymoon with Feosva Leshcheva visited the International Exhibition in Kensington, now the location of the Natural History and Science Museum. One wonders how they afforded such an ambitious, expensive journey when Dmitri was only twenty-eight.

1884: Tercentenary of Edinburgh University
1887: British Association for the Advancement of Science Meeting in Manchester
1889: Visits London to receive the Faraday Medal from the Chemical Society
1894: Receives Honorary Degrees at Oxford and Cambridge Universities
1895: Comes to London to discuss with Ramsay the explanation of different densities of two different 'types' of nitrogen
c.1895-1900: Visits (note plural) to meet representatives of Johnson, Matthey & Co
1905: Receives Copley Medal from the Royal Society. The initial page of the Memorial Lecture in 1909 states that it was his last appearance in Britain [15].

From the above evidence, how many times did Mendeleev visit Britain? William Tilden wrote 'several times' in his obituary of Mendeleev [16]. Babaev wrote "nine times" in a letter to me. The chief uncertainty is with the number of visits to Johnson, Matthey & Co. There are other occasions linked to Mendeleev, such as receiving an honour, when his presence is not specifically mentioned.

### Establishing Standards

In 1890 Mendeleev resigned his professorship to dissociate himself from the government's harsh suppression of student protests. From 1893 he served as Director of the Bureau of Weights and Measures in St Petersburg. The nature of his work is illustrated by his article "On the weight of a cubic decimetre of water and its maximum density". Data was to four or five figures [17]. An important task was to create standards of mass and length. He contacted the English company Johnson, Matthey & Co which specialised in precious metals. They made him a large ball of ninety percent platinum and ten percent iridium, kept inside a glass cabinet which provided the mass standard. The two metals are exceptionally unreactive and an excellent choice for standards.

### Selecting Arctic Equipment

The Russian Navy sought specialist apparatus for Arctic use. Mendeleev wrote this letter of thanks for help [18].

> To Professor Thorpe FRS, Principal of the Government Laboratories, London
> Des Poids et Mesures, 29 January St Petersbourg
>
> Your letter of the 27th January 1899 .... I have received and beg you to accept my thanks for the information you have sent me about magnetic instruments used by the British Arctic Expedition.

Royal Society Archives from 1901 contain an ornamental envelope addressed to Monsieur le Professeur Thorpe. The text ends "with best compliments, D I Mendeleff", which possibly could be linked to the above. Mendeleev was one of the three designers (and the only scientist involved) of *Ermak,* said to be the first icebreaker able to cope with thick polar ice. It was built at Newcastle and commissioned in 1898.

### A Tale of Three Professors

Thomas Carnelley (1852-1890) was an Aberdeen chemistry professor who had previously studied at Owens College and been a private assistant to Henry Roscoe in Manchester. Carnelley had determined many physical properties (melting point, conductivity etc) of substances which substantiated the position of elements in the periodic system. Some years ago, I found a florid translated letter, part of which follows.

> 27 January 1890, St Petersburg, Much respected Sir Henry, The labours of Professor Carnelley, connected with the periodic law of the elements, have been so remarkable that the history of the subject would be unacceptable if his name was omitted. .... Because I value very highly the services rendered by Professor Carnelley, I think it my duty to express my opinion of him to you, hoping that for old friendship's state you will not censure me for reminding you of matter ....

Sadly, Carnelley died that autumn, aged thirty-eight.

Whilst Mendeleev is best-known for developing the periodic classification of the elements, he applied his scientific understanding to many situations. He had wide knowledge, a sharp brain, certainly the reverse, in English, of his initials DIM.

### Special Thanks

I was particularly helped by two Russian academic chemists, Professor Eugene Babaev contacted by email and Dr Yuri Pavlenko, who I met when holidaying on the Crimean Peninsula. Dr Pavlenko carried out investigations to solve queries, partly using my 1951 Mendeleev biography in Russian and helping identify people from captions to photographs. Thanks also to the librarians and archivists contacted at places mentioned in the text.

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5. Royal Society Council Minutes, 12 May 1892.
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9. This section contains details from various sources, mainly *Abstracts of Proc. Chem. Soc.* 1889, **5**, no. 70, 93.
10. Letter from Chemical Society to Mendeleev to celebrate twenty-five years of the Russian Physico-Chemical Society quoted in *Chemical News,* 1893, **68**, 273.
11. See resources at http://royalphil.org/history/ including *No Mean Society: 200 Years of the Royal Philosophical Society of Glasgow* (Glasgow: Royal Philosophical Society 2003), quote on 44.
12. Most detail in this section is from the Special Collections of the Edinburgh University Library.
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16. W. Tilden, Obituary of Mendeleev, *Proc. Roy. Soc. A*, 1911, **84**, xvii.
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18. D. Mendeleev, Letter to Thorpe, Royal Society Archives, Th33.

Gordon Woods

## BOOK REVIEWS

Glen E. Rodgers, *Traveling with the Atom – A Scientific Guide to Europe and Beyond* (Royal Society of Chemistry, 2020), Pp. xxxii + 551, ISBN 978-1-78801-528-8, £29-99.

This weighty book is an example of a popular recent genre, that of the travel book associated with a scientific topic. The first of the nineteen chapters explains the arrangement of material, and gives examples of other science guides. Chapters two to seven cover the UK and Ireland while the remainder principally concern parts of continental Europe. Each begins with a 'Quick Look' at the places described and a digest of the contents, ending with a brief summary of the history of each 'atomist' and their associated residence sites and/or monuments discussed. A one-to-five star system indicates the relative importance of these. Longitude/latitude coordinates are given of such locations with monochrome maps (called charts) in Google style. Visiting details for these sites are well described, and contact details are given if special visiting requests are necessary.

The book's canvas is huge. Sub-atomic particles are of course included, and some 200 chemists or physicists covered. It is not until chapter four that we meet John Dalton, and the account given of him is excellent – as it should be – and full of fascinating detail. He could not afford to join the Manchester Portico library (founded in 1802 and still existent), so was appointed 'Clockman' *in lieu*, his job being to clean the Portico's Grand Clock. There are many other interesting facts – for example, Volta (included because his researches on electricity involved the then-unknown electron) is commemorated in Como by a full-size Grecian-style temple, a functioning lighthouse and five plaques. A good chapter is devoted to memorials of atomists in Westminster Abbey – Davy, Dirac, Clerk Maxwell, Faraday, Joule, Kelvin, Ramsay, Rayleigh, Rutherford and J. J. Thomson - this list gives some idea of the diversity of those featured in the book.

The arrangement of material is sometimes unwieldy – for example I would have liked more on Moseley than two pages and less on Boyle who has twenty. Inevitably there are a few errors - e. g. Michael Frayn, not Michael Flynn, wrote *Copenhagen*. The book is heavy (the paperback weighs 820 g. and is 3 cm. thick); one is unlikely to pack it for a holiday, though it would be an excellent armchair traveller's companion. It seems to be available as a rather flimsy paperback only; an e-version would help real travellers.

Each chapter ends with general references and 'additional reading' selections; the name and subject indices are excellent and there are good monochrome illustrations. It would have been nice, though perhaps impracticable, to have at least one reference to a key original paper by the scientists cited. Still, I liked this book and learned a lot from it. Highly recommended for the armchair or deckchair traveller.

Bill Griffith

Clare E. Wilkes, *Framed by a Smoking Gun: The Explosive Life of Colonel B.D. Shaw* (The Book Guild Ltd., 2019), Pp 339, ISBN 978 1912575 473, £9.99 paperback.

This book is a tribute to Colonel Brian Shaw, a chemist who was famous for his demonstration lecture on explosives. A lecturer in the chemistry department of what was to become the University of Nottingham, he gave his first public lecture on explosions in October 1930. He went on giving it until about 1990, stopping when he was over ninety years of age. In 1986 and again in 1988, he travelled to America to give the lecture at the University of California at Berkeley. This remarkable lecture-demonstration lasted almost two hours and was celebrated by a variety of awards, including a special award by the Royal Society of Chemistry in 1985. The Chemistry Department at the University of Nottingham now gives the Shaw Medal for outstanding lecture-demonstrations, keeping both his name and the art of the lecture-demonstration alive.

Brian Shaw had an interesting life. Born in Ilkeston in 1898 of middle-class parents (his father, Sam, became mayor of Ilkeston in 1910), Brian was educated at the County Secondary School, leaving in 1914 to become an apprentice pharmacist. He did not enjoy the work, and in 1915 switched to become a pupil-teacher at a boys' school. Towards the end of 1915, he got a local girl pregnant, and married her at the young age of eighteen. The marriage was not a success; they had one child, a boy, who lived for only four months, and Brian does not seem to have treated his wife Margaret particularly well. They hardly lived together at all and, in fact, the love of his life was a lady called Alice. He met her a few years after his marriage and lived with her in relative secrecy for sixty years, finally marrying her in 1989 after Margaret died. This aspect of his life makes uncomfortable reading.

When conscription was introduced in 1916, Brian joined up. This began a life-long interest in things military. For most of the rest of his life, Brian was associated with both the army, through the local OTC, and shooting, through his participation in competitive rifle and pistol shooting. He was a good enough shot to be in the England team in the late 1940s.

After World War I, Brian decided to study chemistry, which he did at University College Nottingham. He took the external BSc degree of London University, which meant travelling to London to sit his exams. He did so with such success that he obtained First Class Honours in 1922. He was immediately recruited as a research student by his professor, F. S. Kipping, but a year later took a position as lecturer at Queen Mary College, London, under J. R. Partington. A few months later, Kipping tempted him back to Nottingham with a higher salary, and that was where he stayed for the rest of his career. In 1926, he was awarded his PhD.

Brian Shaw spent his life teaching, publishing only nine papers in his career. He eventually retired in 1965, but continued with his famous lecture-demonstration for many more years. He also appeared as an expert witness in court cases concerned with explosives. Eventually the years caught up with him and, when his wife Alice died in March 1998, he moved into a care home. On 7 November that year he passed away.

Brain Shaw was able to continue his involvement with chemistry for an enviably long time after his formal retirement. This book gives a full account of his life, with interesting insights into its various aspects. I did find it some elements disappointing, though. Details of his wartime experiences, including five years from 1940 as a prisoner of war are covered in too much detail, and run to sixty-five pages out of 305 for the entire book. There are tantalising glimpses of ideas not fully developed: Why, after the war, was Brian Shaw contemptuous of the new physical methods of studying chemical reactions, and how could he have taught a worthwhile course in organic chemistry in the 1960s without any reference to mechanisms? I also found myself out of sympathy with many of his enthusiasms, not only the OTC and shooting, but also Freemasonry, with which he was heavily involved. Plus, at least one specific detail is wrong: Kipping cannot have closed the chemistry department for a day in 1922 for the staff to all go to the Test match, because there were no Test matches in England that summer.

This book has obviously been written with enormous affection for its subject. Colonel Shaw elevated the lecture-demonstration to a very high standard, and his role in inspiring several generations to study chemistry cannot be overemphasised. He deserves to be remembered, and this book does him great service by keeping his memory alive.

John Nicholson

Kit Chapman, *Superheavy –Making and Breaking the Periodic Table* (Bloomsbury Sigma, 2019), Pp. 304, ISBN 978-1-4729-5389-6, £16-99.

The superheavy elements are defined by the author as 104 (rutherfordium) to 118 (oganesson) inclusive; only since 2016 has IUPAC confirmed their existence and names. This book seeks to survey them in three parts divided into twenty-one chapters and an epilogue. The author has travelled widely for this purpose: to the Oak Ridge National laboratories in Tennessee, the Lawrence Berkeley National Laboratory, the RIKEN cyclotron in Japan, the Russian facilities at Dubna, and a new cyclotron in Canberra.

The first part, "Children of the Atom", very briefly considers the concept of the element and quickly moves to cover the period 1935 – 1955, starting with Fermi's mistaken belief that he had made transuranic elements. The production by others of transuranics, made by transmutation, follows: neptunium, plutonium, americium, curium, berkelium, californium and mendelevium (elements 93 to 98 and 101). There is a short section on the $^{235}U$ and plutonium atomic bombs, and the isolation of einsteinium and fermium (99, 100) from nuclear debris from the 1952 American nuclear test. Production of all these involves light bombarding species, mostly alpha particles.

"Transfermium wars" covers the main matter of the book, the superheavy elements. Heavier reacting particles have to be used, e.g. for rutherfordium, $^{12}C$ bombards californium. This section is largely concerned with the many disputes between the American, German and Russian laboratories concerning priority of elemental manufacture and nomenclature. There is an inconclusive section on "islands of stability" – the expectation that some of these elements might have enhanced stabilities of existence.

The third part, provocatively entitled "The End of Chemistry" (about as pertinent as Fukuyama's "The End of History") brings us up to date (2019) with elements 114 to 118 and the possibility that relativistic effects amongst other factors could mean that the heaviest elements cease to obey behaviour predicted by the Periodic Table. However, though there is no shortage of computation of possible properties, so few atoms of these species have been made that no real chemical work on them has yet been feasible.

For me the book is disappointing - its subject, both chemically and historically, is interesting and important, but the approach taken here is at times flippant, chemically simplistic and excessively journalistic. While I'm happy to see inclusion of the old chestnut: "A neutron orders a drink. 'How much?' he asks; 'to you, no charge' replies the barman"; and the suggestion of a postal address composed entirely of elements "Seaborgium/Lawrencium Berkelium/Californium/Americium", this approach gets a bit wearing. The arrangement of material, though roughly chronological, is often confusing, and the poor index gives little help. The treatment, both historical and chemical, lacks rigour and depth – for example it is often difficult to discover from the book how these elements were made. A few nuclear equations would have helped enormously.

Bill Griffith

## CALLS FOR PAPERS

13th International Conference on History of Chemistry (ICHC), Vilnius 18-22 May 2021

Since 1991, when the first meeting was organized in Veszprem (Hungary), the Working Party on the History of Chemistry (WPHC) of the European Chemical Society (EuChemS) organizes an international conference on the history of chemistry, open to colleagues from all over the world. Thirty years later, the thirteenth International Conference on History of Chemistry (13ICHC) is currently planned to be held in Vilnius (Lithuania), from 18 to 22 May 2021.

See: https://www.ichc2021vilnius.chgf.vu.lt/.

The conference will be hosted by Vilnius University (established in 1579), in the premises of the old city. The Department of Chemistry was established in 1797, still holds a position of one of the most popular departments at the University. The conference will include scientific sessions, key-note lectures, the WP business meeting, a poster session as well as social events such as excursions, receptions, and a conference dinner. It will be organised in conjunction with the Belorussian-Lithuanian-Polish Jędrzej Sniadecki Memorial Conference "Frontiers in Molecular Life Sciences" – JSMC2021. Jędrzej Sniadecki was the first head of the Chemistry Department at Vilnius University during 1797–1822. The conference JSMC2021 will continue to commemorate the 250th anniversary of Sniadecki's birth.

**Important Dates***

Deadline for submitting proposals: 1 December 2020

Notification of acceptance: January 2021

Provisional program: Early February 2021

Final program: April 2021

Conference dates: 18-22 May 2021.

*Due to the Covid-19 pandemic, it might be necessary to alter some dates at a later stage.

**Proposal Guidelines**

The Steering Committee encourages the submission of panel/session proposals, but also accepts the submission of stand-alone papers. The 13ICHC welcomes proposals on any topic on the history of chemistry, broadly understood, including historical works on molecular sciences, life sciences, industry, technology, and education. It also welcomes papers on the teaching of history of chemistry, in order to reach out to the wider community and to the younger generation. All proposals must be in English, the language of the conference. Submitted abstracts and session proposals (max. 200 words) will be subject to review by an international Advisory Committee. Sessions should include about three to five papers, and no more than one session can be proposed by the same organizer. There is a limit of one paper per presenter (including the papers listed inside a panel or a session). All paper proposals must use the templates provided on the conference web site.

## FORTHCOMING ONLINE SYMPOSIUM

Adventures in Chemistry and Technology: Exploring the Legacy of Nineteenth Century Innovation in Textiles, Jewellery and Materials, 20 September 2020

Supported by the Society of Dyers and Colourists, this one-day symposium will bring together scholars from a wide range of disciplines,including design historians, jewellery historians, economic and industrial historians, textile, fashion and jewellery practitioners, historians of science, museum and gallery curators, trade bodies and company archivists to discuss material histories of textiles and jewellery.

- historical innovation in aesthetic design and modern textile design
- fashion and jewellery-materials
- chemistry and technologies of making
- stories of chemists and early material scientists contributing to the world of craft and design and of makers and artisan manufacturers becoming chemists and inventors from c. 1830-1940
- papers directly addressing electrification, new materials, material-textual-visual combinations of art and science and manufacturing, machines and patenting for economic, social or environmental benefit.

It will be hosted online via Microsoft Teams De Montfort University. Registration will open on 20 July 2020.

For further information: https://adventureandlegacy.our.dmu.ac.uk/

### Erratum Winter 2020 *RSCHG Newsletter*

Meeting and Conference Reports: William Crookes (1832-1919)

The caption on page forty-six of this issue should have read as follows:

Image adapted from Reynolds, James Emerson, and Edward G. Mazurs. “Periodic Table in the Style of a Zigzag (James Emerson Reynolds, 1886)”. Glass, circa 1886–1957. Edward G. Mazurs Collection of Periodic Systems Images, Box 1. Science History Institute. Philadelphia. https://digital.sciencehistory.org/works/3197xm60w. Courtesy of Science History Institute.