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Kerry Pendergast

Two Books That Led Me to History of Science and Technology

Introduction

The two previous articles in this series [1] have been entitled "Two books that markedly influenced my chemical career"; both have included teenage reminiscences. If I were to write an article along those lines, I would begin by responding to Nigel Jopson's article (page 16) that I did personally

produce As_2S_3 unsupervised during a lunch break at school [2], which, he specifically suggests, would nowadays cause an "uproar".

However, the Editor has allowed me a different topic and therefore title, as above. The result is that the rest of this article focuses on my more mature years, up and including 2024. After Oxford chemistry finals, I worked in two research groups [3] in the University's Inorganic Chemistry Laboratory. Thereafter, I had six non-academic jobs spanning a wide range of science and technology, mostly doing intellectual property law – not just patents but also negotiating and drafting technology transfer agreements. In parallel with those jobs, both for enjoyment and so as to maintain a broad scientific base, I read a wide range of history of mathematics, science, and technology, acquiring articles, monographs, reference works, and original texts. Ceasing full-time employment in 2009, I continued with intellectual property law on my own account, but was able to spend more time than before on history, including in organising/speaking at meetings of the Historical Group [4].

The Books

The two books that started me on this path were outside the history of science and technology mainstream, even though, as just stated, my library soon became dominated by mainstream works. The books are *Subtle is the Lord – The Life and Science of Albert Einstein* (Oxford: Oxford University Press, 1982), by Abraham Païs (1918-2000); and *Most Secret War* (London: Hamish Hamilton, 1978), by Reginald Victor Jones (1911-1997). I read the books shortly after their publication. Both are still available.

Païs

Païs's book is a scientific biography, written by a top physicist about a great one, explaining the context and development of the ideas of Albert Einstein (1877-1955). Païs engages deeply with the thought of Einstein (whom he knew personally), and assumes his readers have good scientific knowledge.

Païs also carefully placed Einstein's work in the context of previous work. Now, I already knew –

(a) that the equation today written as $E = h\nu$ [5] had emerged from the work of Einstein in the first decade of the twentieth century, who had relied on the work of 1900 by Max Planck (1858-1947), and

(b) that Planck had in turn relied on preexisting experimental data on the emission spectra of black bodies (ones that absorb all incident radiation).

What had always puzzled me, but which Païs explained (pages 2 and 364-5), was why scientists had invested so much effort into creating this data, especially in devising techniques for far infrared radiation (up to λ = 60 µm). Païs observes that it was Gustav Kirchhoff (1824-1887) who had encouraged people to do so. In 1860, Kirchhoff asserted that because the radiation emitted by a black body was independent of the material of which the body was made [6], the spectrum, once determined, would expose an underlying fundamental simplicity; accordingly, such determination was "highly important" – as indeed it turned out to be forty years later.

Another striking account by Païs (pages 245-9) is of the Einstein-de Haas [7] experiment of 1915. This very difficult experiment involved observing the torsional oscillations of a metallic iron cylinder suspended coaxially within a solenoid carrying an alternating current. The experiment offers to a modern chemist or physicist a concrete, simple insight into the magnetism of materials at the atomic level. Contemporarily, it addressed the fundamental question of whether, contrary to classical electromagnetic theory, an electron could maintain constant rotatory motion and thereby be in a "stationary" energy state; by answering this question in the affirmative, the experiment provided support to the planetary model of the hydrogen atom that had been proposed in 1913 by Niels Bohr (1885-1962). But further and more precise proof of such electronic states soon emerged from spectroscopy, and the experiment was mostly forgotten. I myself recently used some original PowerPoint graphics to remind historians and physicists of the experiment [8].

History of science when written by someone such as Païs, with scientific training and serious understanding of subsequent developments, is immediately at risk of being criticised by some people as "Whiggish" or "presentist" [9]. The former term derives from *The Whig Interpretation of History* (1931) in which Herbert Butterfield (1900-1979) criticised political and social historians who were biased in favour of subsequent "progress" up to the present. As matters stood in 1931, a writer on history of science could have avoided such suspicion simply by impartially seeking to understand the background against which historical practitioners were working, being careful –

(a) not to criticise historical practitioners merely because they were later proved wrong, or were hampered by a widely-accepted but unprofitable intellectual framework or by unavailability of good apparatus and pure materials; and

(b) conversely, not to misinterpret historical texts in the direction of modern understanding, e.g. by importing anachronistic significance into words such as "atom" or "molecule" or into superficial resemblances between historical drawings and modern ones.

However, in the past sixty years or so, some historians and philosophers of science have greatly extended the scope of alleged "Whiggish" or "presentist" error (and, as it happens, implicitly to identify errors made by Butterfield when, in his later years, he himself wrote history of science). Thus, in some quarters statements such as the following would be objected to: "What X [the historical practitioner] calls A we now call B" [10], or "X cannot have discovered C as he claimed, for there is now overwhelming evidence that no C exists with the properties he describes" [11], or "What must have happened in X's experiment, unknown to X, is D" [12]. Païs enriches his writing with such statements; I likewise am content, despite the risk, to make such statements, provided that there is evidence to support them and I have the linguistic and scientific skill to interpret that evidence.

A few years ago, the historian of chemistry Bill Brock sought my own scientific expertise (not that I compare remotely with Païs!) to create jointly a short biography of a chemist Robert Fergus Hunter (1904-1963) [13]. In this, we did quite definitely include statements similar to those in the last paragraph when discussing an episode of Hunter's life that damaged his scientific reputation. The episode was a public, aggressive dispute about the electronic theory of chemical bonding. The dispute began with a 1934 paper by Hunter and a physicist Rudolf Samuel (1897-1949) which challenged the "octet rule". The rule, which works well for non-transition elements, had been promoted by the eminent Nevil Vincent Sidgwick (1873-1952); indeed it had previously been espoused by Hunter himself. Hunter and Samuel's paper was arrogantly worded; it disingenuously cited the work of two other major scientists, Linus Pauling (1901-1994) and Christopher Ingold (1893-1970); and *Nature* published blunt criticism of it.

In our article, Bill and I discussed this dispute at such a level that, hopefully, less scientifically knowledgeable readers could get a feel for the dispute while taking our drawings of electronic structures on trust. In principle, we

could have dumbed down the science, discussing only the personalities and the statuses of the disputants; but this would have been to short-change our more scientifically knowledgeable readers. We navigated the confusing terminology that had arisen in this nascent field [14] and correlated it with modern terminology. We assessed what expertise Hunter and Samuel had brought to their 1934 paper, and the contemporary criticism of the paper, concluding that their work lacked competence by the standards of 1934. As a sanity-check on this conclusion, we noted that even in the twenty-first century the octet rule flourishes in university chemistry as a useful first approximation.

Jones

Jones' book is a memoir of his scientific intelligence work during the Second World War (1939-1945). At Oxford, after a First in physics in 1932 and a DPhil in 1934, Jones took up a research fellowship, proposing to do infrared astronomy preparatory to going to the USA. But from 1936 to 1938, still in Oxford and convinced that a war was coming, he accepted commissions from the Air Ministry to research military applications of infrared technology. He then left Oxford actually to join the Air Ministry, where he established a scientific intelligence function. In June 1940, with the grade only of Scientific Officer, he personally presented to the Prime Minister, Winston Churchill (1874-1965), what was known about the system *Knickebein* that guided German bombers to targets in the UK. By 1945, he had risen to Assistant Director level and had been made CBE. However, Jones disagreed with the post-war reorganisation of scientific intelligence, and was happy to escape, with Churchill's endorsement, to a Professorship in Aberdeen.

The book's theme is the application of scientific method to discovering enemy technology and foiling it. Jones warns against jumping to conclusions, such as when there was an unjustified scare about German radar being able to distinguish between British fighters and British bombers (page 243). He recommends Occam's Razor to scientists, the principle that the most likely (but not certain) explanation of a set of observed facts is the simplest. In a sequel, *Reflections on Intelligence* (London: Heinemann, 1989) he contrasts the Razor with Crabtree's Bludgeon, "No set of mutually inconsistent observations can exist for which some human intellect cannot conceive a coherent explanation, however complicated" [15]. He warns (also in *Reflections*) against relying on calculations made without qualitative understanding; his example is Lord Kelvin (1824-1907), who calculated,

contrary to geological evidence, that the earth was only a few hundred million years old.

As well as providing such practical insights for working scientists, Jones's memoirs are of intrinsic value to historians, albeit that they must be assessed for the bias which arises from his being a participant. Likewise, interviews with living scientists [16] and witness seminars [17] are all grist to the historical mill, containing unique information, but possibly biased. A witness account of my own, relating to computational technology from 1966 to more recent times [18], was not I think biased, but memory can be deceptive, so I checked my recollections against artefacts and written sources. My article about the Harwell research site in Oxfordshire (1946 onwards) [19] was not primarily a witness account, despite my having worked there for a couple of years. I believe that, rather than importing bias, my direct experience helped me (a) to compensate for bias in a previous, very favourable account written by a long-term employee, and (b) to identify sources that others might not have considered.

Final Comments

The historical process of seeking out sources and evaluating them can be tedious. But I was mentally prepared: I assisted my wife [20] in her early years as a diplomatic historian, and I also spent many years doing legal work. The latter included interpreting technical documents as of their own time despite terminological difficulties similar to those mentioned above in relation to chemical bonding. I am presently engaged in resolving obscurities in one well-known eighteenth-century French work with the aid *inter alia* of two editions of another well-known work, Pierre-Joseph Macquer's (phlogistonist) *Dictionnaire de chymie*. But, following Païs's example, I also use modern knowledge to sanity-check the experimental observations reported in the work in question.

The project just mentioned is typical scholarly history of science. But an advantage of being an independent scholar is that I am not confined to this; I may address any question that attracts me. My interest in Michael Faraday (1791-1867) and Dr John Snow (1813-1858), associated contemporarily with now-invalid street addresses, resulted in a guide to finding historical locations in London despite the vast extent, from 1855 to 1939, of legislatively-enabled official street renaming and house renumbering [21]. Study of Isaac Newton (1642-1727) not only allowed me to help a little with a new translation of *Principia*, but also led me to pose and solve a

“recreational mathematics” problem in gravity [22, 23]. Following my witness account of historical calculation technology, I identified a class of awkward-looking equations that, unexpectedly, could have been readily handled without electronic computation [24]. Having read accounts of a compact portable barometer that was in common use from *ca* 1600 to *ca* 1900, I worked out its physical chemistry [25]. And as the junior author of a regular scientific paper [26], I included historical information that attracted attention and helped promote the paper [27].

Païs and Jones set me on a path that I have greatly enjoyed following.

References and Notes

1. Henry Rzepa, *RSCHG Newsletter*, Winter 2024, **85**, 1-15; Nigel Jopson, *RSCHG Newsletter*, Summer 2024, **86**, 15-20.
2. I followed Experiment 135 at page 648 in a handed-down copy of the information-packed book, T.M. Lowry and A.C. Cavell, *Intermediate Chemistry*, 6th edition (London: MacMillan, 1954).
3. In the groups of Peter G. Dickens and Lionel A.K. Staveley, studying the thermodynamics of solids.
4. Presentation of an RSC plaque in Penzance to honour Humphry Davy, 2015; centenary of H.G.J. Moseley, 2016; centenary of induced transmutation, 2019; sesquicentenary of molecular chirality, 2021.
5. $E = h\nu$ is the foundation stone of quantum chemistry, delivering, especially with spectroscopy, key insights into chemical structure and bonding.
6. Compare the fundamental equality of gravitational and inertial mass of any body regardless of the material composing it.
7. Wander Johannes de Haas (1878-1960).
8. Michael Jewess, “The Einstein – de Haas experiment of early 1915: so important to Einstein that he interrupted his work on General Relativity for it”, lecture, *4th International Conference on the History of Physics* (Dublin, Trinity College, 8-10 June 2022).
9. *Bull. Hist. Chem.*, 2022, **47**(1), numerous articles; Michael Jewess, “Essay review”, *RSCHG Newsletter*, Winter 2023, **83**, 47-53, Annex; Keith M. Parsons, *Why it’s Ok to Trust science* (London: Routledge 2024), Chapters 1 to 5; and citations therein.

10. Example, equating Joseph Black’s “fixed air” with “carbon dioxide”.
11. Example, rejecting Noddack and Tacke’s claim to have discovered element of atomic number 43.
12. Example, commenting that the vacuum or sample purity must have been poor when Lavoisier reported that charcoal evaporated when heated in a vessel attached to a vacuum pump.
13. William H. Brock and Michael Jewess, “Unwise Relationships and an Unsound Valence Theory: The Chemical Career of Robert Fergus Hunter (1904–1963)”, *Ambix*, 2021, **68**(4), 407-430.
14. “Valence”, “valency”; “linkage”, “bond”; “coordinate”, “dative”; “resonance”, “mesomerism”.
15. Jones’s publishers were probably unaware that he was referring to the Crabtree Foundation https://www.ucl.ac.uk/crabtree, of which Jones, a keen practical joker, was one of the first “Scholars”. The Foundation has annual dinners to celebrate the extraordinary exploits of the otherwise undocumented Joseph Crabtree (14 February 1754 – 14 February 1854).
16. Bernadette Bensaude-Vincent has done many of these.
17. These are common in relation to governmental topics; once the official papers are open, retired civil servants (even retired spies!) attend. Our own Historical Group meetings frequently have eye-witness speakers or audience members.
18. Michael Jewess, “Calculating Chemistry: How it Used to be Done, a Witness Account”, *RSCHG Newsletter*, Winter 2023, **83**, 26-37 (hard copy pages mis-ordered, RSC website easier). The article includes photographs of a hand-cranked calculator, of mathematical tables, and of a slide rule.
19. Michael Jewess, “Harwell Old and New: Its Renaissance as Symbolised by the Relocation of an RSC National Chemical Landmark Plaque”, Forschungs-Neutronenquelle Heinz Maier-Leibnitz (FRM II), 2019, https://neutronsources.org/media/harwell_old_and_new___a_perspective_by_michael_jewess_dec19.pdf.
20. Professor Kathleen Burk.

21. Michael Jewess, "The 'Great Renaming': Locating History of Science in London", *Viewpoint*, October 2021, **125**, 6-8 (hard copy corrupt, instead see BSHS website).

22. Isaac Newton, *The Mathematical Principles of Natural Philosophy*, translated and annotated by Charles Leedham-Green (Cambridge: Cambridge University Press, 2021).

23. Michael Jewess, "Optimising the Acceleration Due to Gravity on a Planet's Surface", *Mathematical Gazette*, 2010, **94**, 203-215.

24. Michael Jewess, "$xy = \cos(x + y)$ and Other Implicit Equations that are Surprisingly Easy to Plot", *Mathematical Gazette*, 2024, **108**, 1-11. The cover of the issue features a hand-cranked calculator.

25. Michael Jewess, "An Equation for the 'Weather Glass' ", *Physics Education*, 2024, **59**, 035006.

26. Michael Jewess and Robert H. Crabtree, "Electrocatalytic Nitrogen Fixation for Distributed Fertilizer Production?", *ACS Sustainable Chem. Eng.* 2016, **4**, 5855–58.

27. Michael Jewess, "Davy Hits the Headlines Again", *RSCHG Newsletter*, Summer 2017, **72**, 28-39 (hard copy), 15-16 (RSC website online). Corrigendum: interchange "cathode" and "anode" between equations (R2) and (R3).

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New Gravestone for John Newlands Unveiled

John Newlands (1837–1898) is famous for his development of a periodic law of the elements in 1864, five years before Dimitri Mendeleev and Lothar Meyer. Unfortunately, he called it the Law of Octaves, which led to considerable ridicule from other chemists. Henry Enfield Roscoe gave Newlands priority for the idea, in his major *Treatise of Chemistry* in 1879, despite being a friend of Meyer. Newlands campaigned even more strongly for recognition after the Royal Society awarded Mendeleyev and Meyer its Davy Medal for the discovery of the periodic law in 1882. He published a book *On the Discovery of the Periodic Law* in 1884 and eventually he, too, was given the Davy Medal in 1887. Meanwhile, he had established himself

as an analytical chemist in 1864 and four years later became chief chemist of James Duncan's London sugar refinery.

The gravestone unveiling, with attendees including Bob Flanagan (5th from left) and Peter Morris (6th from right) with Peter Newlands to his right. Photograph courtesy of Heritage of London Trust/ @holtoflondon

Newlands was buried in West Norwood Cemetery, near Dulwich, but his gravestone had fallen into a state of disrepair. His descendant Peter Newlands set up a fundraising campaign to restore it, to which the RSC via the Historical Group contributed. Assistance was also given by the Heritage of London Trust. As part of the restoration project, the stone was refaced and the memorial lettering cut and lead infilled to match the existing lettering. The new gravestone was unveiled on 9 September 2024 by Peter Newlands and Peter Morris, representing the Historical Group. Unfortunately, it rained during the ceremony, but there was a good turn-out with fifteen people present. There were short speeches by Peter Newlands and Peter Morris, and teachers from a local school showed the work of their pupils who had studied the life and impact of Newlands. Bob Flanagan, who lives locally, also represented the Historical Group.

Peter Morris