Perspectives on Chemical Biography in the 21st Century

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Edited by

Isabel Malaquias and Peter J. T. Morris

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INTRODUCTION

To the memory of
Prof. Masanori Kaji

The present publication contains twenty-four texts previously presented at the 10th International Conference on the History of Chemistry devoted to the theme Chemical Biography in the 21st Century. It opens with the late Masanori Kaji's paper that he unfortunately was unable to deliver himself through ill-health. Sadly, he passed away in July 2016, aged 60. He regularly attended the International Conferences on the History of Chemistry and collaborated with several European and American colleagues. This volume stands as a memory of the last presentation of a very kind and thoughtful colleague. In his presentation, the diaries of Riko Majima are analysed and discussion is presented on the implications of this archive for the study of the history of modern chemistry in Japan.

Two of the three keynote papers presented are published here, namely by Jorge Calado and Bernadette Bensaude-Vincent. Calado takes "as a starting point the correspondence of Michael Faraday, and prompted by a few books that hide or suppress crucial images, the author ponders a present in which historical sources have migrated to the ether, where they risk being deleted at the click of a mouse." Having migrated online, our past can be saved, but be corrupted and easily destroyed as well, and he also considers "the current generalization of fraud, for personal gain, in scientific research," another drawback for historians of science.

Bensaude-Vincent argues on the necessity of "improving historiographical practices" and of a "better understanding of the role of chemistry in our culture and society" relying on Lorraine Daston's appeal for writing on scientific objects that calls for the extension of the biographical genre to the chemical elements, here specifically to carbon. The significance of a carbon biography illustrates how objects and societies are mutually interrelated while demonstrating that carbon is much more than a chemical element and she "calls for multiple systems of knowledge".

These papers are followed by five thematic sections. Section I deals with Sources, Section II is devoted to Physical, Theoretical and Inorganic

Chemistry, Section III is concerned with Aspects of Biography, Section IV with Facets of Nineteenth-century Chemistry and Section V gathers together some Traits of Chemistry in Portugal and Spain.

In Section I, Jeffrey Johnson reflects on the value of oral history for the history of contemporary chemistry and related disciplines, namely the transition from classical chemistry to synthetic biology. He details his direct experience in two projects. In the case of German women in chemistry from 1895 to 1945, he used oral history as an additional strand to the archival material. In the second case, he used the oral-history interviews with contemporary scientists working in a new interdisciplinary discipline (synthetic biology) as one of his main sources of information. Ana Alfonso-Goldfarb, Marcia Ferraz and Silvia Waisse reflect on the role oral history plays in documenting 20th century Brazilian chemistry, considering the "memory" projects that higher education institutes usually promote in celebration of their own past and the interviews given by some pioneers to their students and disciples, although frequently not following a historical methodology. They conclude that although temporal proximity can be an obstacle to historical accuracy, the combined use of oral history with different other types of written documentation can result in a new and different image of science. Completing section I, Muriel Le Roux puts forward the question of what methodology is appropriate for a contemporary history of chemistry, considering that being a hybrid discipline, both academic and industrial, and mainly after the 1960s, the production of documents was enormous, illustrating both the co-operation and interaction between these two environments. Nevertheless, she reflects that the historian's work is not thereby facilitated because of the lack of a systematic conservation policy in the different archives (public or private) and the evolution of technology resulting in a lot of disappearing sources of information (telephone conversations, emails, preliminary texts, Post-it notes, etc.). At the same time, the extended collaboration and co-production of documents imply different actors, frequently linking different institutions, requiring the consultation of all the archives involved while it is not implied that they share repositories or that access can be simplified. And she presents what she calls "the methodology of the fellowship or the *compagnonnage*" that enables the closeness between the historian and the actor/witness, emphasizing that "trust, goodwill and mutual respect allow the widest possible access to the sources and to the understanding of science."

Section II begins with Ana Simões' paper where the author reflects on some different previous aspects to her intention of writing a biography of

the quantum chemist Charles Alfred Coulson, beginning with assessing the sort of biographical publications published so far, and addressing three prior questions: "1) Why is Charles Alfred Coulson among those who did not get a biography?; 2) How to write Charles Alfred Coulson's biography or what perspective(s) to take?; and lastly 3) Why write such a biography?" In the following paper, Jay Labinger presents the contrast between the successful world-class chemistry programme led by A. A. Noyes in Caltech after 1920 and the misrepresentation of inorganic chemistry after the World War II period, considering it was not simply a manifestation of general trends, but much related with Don Yost's personal characteristics and behaviour, namely towards Linus Pauling. These were key factors in retarding the growth of Caltech inorganic chemistry that could otherwise have achieved a major breakthrough in noble gas chemistry. Marcin Dolecki reflects on the considerable merits of the Polish physicist and physical chemist Ludwik Wertenstein (1887-1945) in the field of radioactivity and related phenomena, his eleven notebooks at the Archive of the Polish Academy of Sciences, with personal notes on the Second World War, and his correspondence with Ernest Rutherford, James Chadwick, Max Planck, Kazimierz Fajans, Paul Langevin, and Lise Meitner. However, Wertenstein's life still lacks detailed study and a full-length biography. In their paper Letícia Pereira, Olival Freire Jr., and Artur Mascarenhas elaborate the quest for an integrated biography of Wilhelm Ostwald (1856-1932), avoiding the separation of his scientific work from his energetics and anti-atomistic convictions. They confront the context of Nobel Prize awarding to Ostwald in 1909, his discourse at the Nobel Academy and the query as to whether energetics was taken into account in his nomination to the Prize. Gordon Woods details the extraordinary short life of Henry Moseley (1887-1915), whose two papers on high frequency spectra of elements, parts I and II, would get worldwide recognition together with his justification of Mendeleev's periodic table sequence. He was even nominated for both physics and chemistry Nobel prizes, but having volunteered to fight in the First World War, he was killed by a Turkish sniper during the ill-fated Gallipoli campaign.

At the beginning of Section III, Sonnet's paper presents results on the study of the *Caisse des Recherches Scientifiques* and *Caisse Nationale des Sciences*, from 1931/32 and 1938/39, when the creation of the present *CNRS* (*Centre National de la Recherche Scientifique*) took place. The author was able to reconstitute the researcher population granted by the *CNS* between 1931/32 and 1938/39, in terms of gender distribution along the seven specified areas, concluding that in what concerns chemistry the

scholars are referred to as chemists, without specifying the nature of their works. It goes a bit further by focusing on the individual scientists, their living conditions and career developments. Gisela Boeck's paper investigates some aspects of science history and chemical education in the German Democratic Republic. In particular, she pays attention to the Teubner Publishing House which released, over a 30-year period, one hundred popular biographies of outstanding natural scientists, technicians and physicians to be used by teachers, students and other interested members of the public. The book series is presented and analysed, although a more extensive evaluation of content will be followed in the near future. Birute Railiene focuses her attention on the biographical study and published works of the Polish chemist and physician Andrew Sniadecki (1768-1838) whose studies abroad put him in contact with the novelties of Lavoisierian chemistry and Edinburgh medical studies. Returning to the reformed Vilnius University in 1797 he endorsed studies of chemistry and biochemistry, having produced a chemistry textbook in the Polish language and dealt with the difficulties of nomenclature. His public lectures became famous and at present they have been reintroduced at the university that celebrates his birthday and pioneering work while they have also used the moment to gather together historians of science and of chemistry with more general enthusiasts. Sérgio Rodrigues tries a different approach to answer his question title on what can chemists and the public learn from biographies of chemists by considering the possibility of using those biographies to "touch the 'heart' of the public", rescuing chemistry from invisibility and humanizing the way people see chemistry without abandoning historical accuracy, "but always exploring the complexity of the human mind and the serendipity of its actions". Maria Gomes ends this section, focusing on the chemistry and chemical skills behind Albrecht Dürer's paintings and the lots of money spent in acquiring expensive pigments, many of them from Venice and Antwerp, the hard work of grinding them to the desired size, mixing them with suitable vehicles, and taking health risks when working with poisonous compounds.

Section IV and Facets of Nineteenth-century Chemistry gathers the papers by Ignacio Suay-Matallana on Antonio Casares-Rodríguez and his son José Casares-Gil as a family of chemistry and experts; Alexander Borodin's double vocation, as a musician and a chemist, by Willem Vijvers who poses questions on what is a chemical biography and what is a musical biography; and Yona Siderer's paper on the Japanese Udagawa Youan's (1798-1846) translation of light and heat reactions in his *Kouso Seimika*. Peter Morris reflects on the lack of attention given to laboratories in

biographies, referring to several excellent chemistry biographies in which the laboratory appears and other cases where accounts of laboratories have been given even less space. He then presents how biography and laboratory history can fruitfully interact exemplifying with the life of the famous chemist Wilhelm Hofmann (1818-1892), arguing as published in his recent book on the history of the chemistry laboratory that Hofmann's creation of a new type of laboratory both connects with his earlier career and affected it thereafter. Hofmann's willingness to share his knowledge of laboratory design abroad enabled the creation of a pattern for the chemistry lab which had four features: "the institute's director and leading professors; organic chemistry; practical research, especially organic synthesis; and postgraduate training in practical work". João Oliveira and António Morais follow the connection between glassblowers and scientists, a link frequently forgotten and exemplify with different cases where some glassblowers' names survive and where the glass skills of some well-known scientist have elapsed.

The last three papers enable some traits of chemistry in Portugal and Spain. Ana Cardoso de Matos and Ignacio Garcia Pereda evoke the work of the Portuguese chemist Sebastião Betâmio de Almeida (1817-1864) whose activities in teaching, industrial activity and intervention in the Leiria pine forest were determinant in the new resin industrial developments managed by the Forestry State Department. Maria da Luz Sampaio and Isabel Cruz discusses the life and work of the Portuguese chemist Joaquim de Santa Clara Sousa Pinto (1803-1876) who aside from his activities as a chemistry professor at Porto Polytechnic Academy and at the Industrial School, conceived and patented a device able to produce ethylene gas from vegetables. Pariente Silván presents aspects of Mariano Santisteban's (1821-1886) training and teaching career in nineteenth-century Spain.

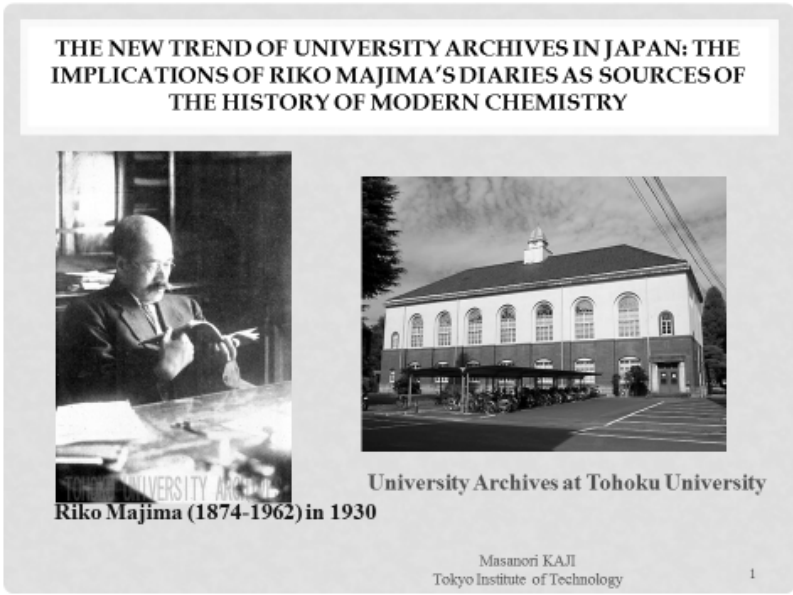
Last but not least we would like to acknowledge the assistance of Brigitte Van Tiggelen, chair of the Working Party on the History of Chemistry of the European Association for Chemical and Molecular Sciences, Ernst Homburg, and all those who contributed to the production of this book.

Isabel Malaquias and Peter Morris

Aveiro, July 2018

THE NEW TREND OF UNIVERSITY ARCHIVES IN JAPAN: THE IMPLICATIONS OF RIKO MAJIMA'S DIARIES AS SOURCES OF THE HISTORY OF MODERN CHEMISTRY

MASANORI KAJI[1]



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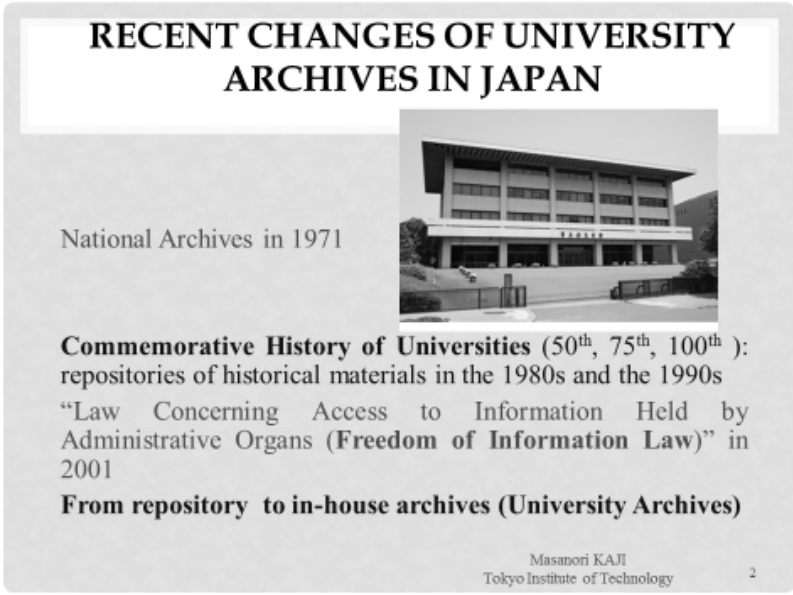


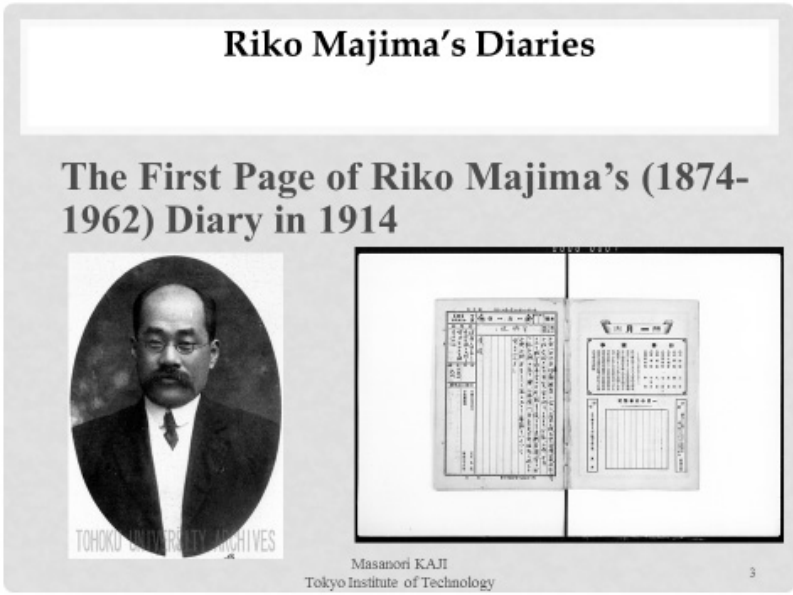
Recent Changes of University Archives in Japan

Until recently, one of the obstacles to studying the history of modern chemistry in Japan was the country's lack of systematic archival systems. After the Meiji Restoration, Japan started its full-fledged modernization and introduced many new institutions, but not contemporary archival systems. Modern Japanese were eager to destroy and replace everything old. Accordingly, they did not pay much attention to archival materials. The so-called "Cabinet Library" was established in 1884 to store various books and manuscripts before and after the Meiji Restoration, which included some official documents such as governmental officials' appointments and dismissals, and records of the Cabinet's decisions. The National Archive was established only in 1971 based on the "Cabinet Library."

This lack of attention caused many difficulties for researchers studying the biographies of scientists in Japan, including those of chemists.

However, many university archives were established thanks to the compilation of university history to commemorate the 50th, 75th or 100th anniversaries in the 1980s to 1990s. However, the past twenty years have

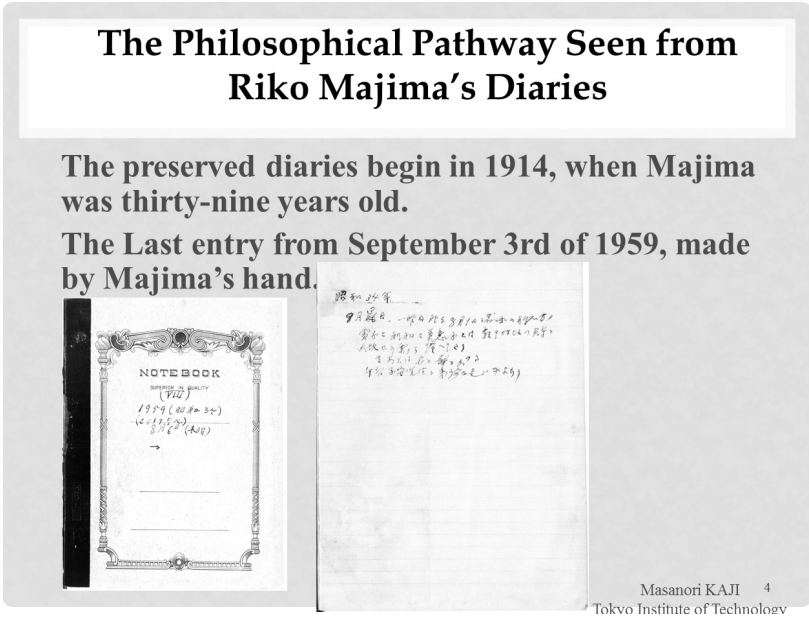
brought significant changes as Japanese academics have realized the importance of archives and established such repositories at many universities. The Enforcement of the "Law Concerning Access to Information Held by Administrative Organs (Freedom of Information Law)" in 2001 was another turning point. The Law requires in-house archives, which hold records created or received by universities. Leading national universities founded new university archives or reorganized old repositories into archives.



Riko Majima's Diaries

Thanks to this new movement, researchers have gained access to various valuable archival materials. The case of Riko Majima (1874-1962), a first-generation research organic chemist provides an excellent example of this change. Majima kept diaries from his youth until three years before his death at the age of 87. For a considerable period of time in Majima's long life, he regularly kept his diaries. His original diaries were inherited by his second son Yukio after Majima's death, and passed on to Yukio's wife Hiroko, a resident of Kyoto, when her husband passed away. In 2007, microfilms were taken of the diaries and stored in the Tohoku University Archives, and it is now possible for researchers to view these microfilms,

which have been made accessible to the public.[2] This paper will analyze Majima's diaries and discuss the implications of this archival awakening for the study of the history of modern chemistry in Japan.



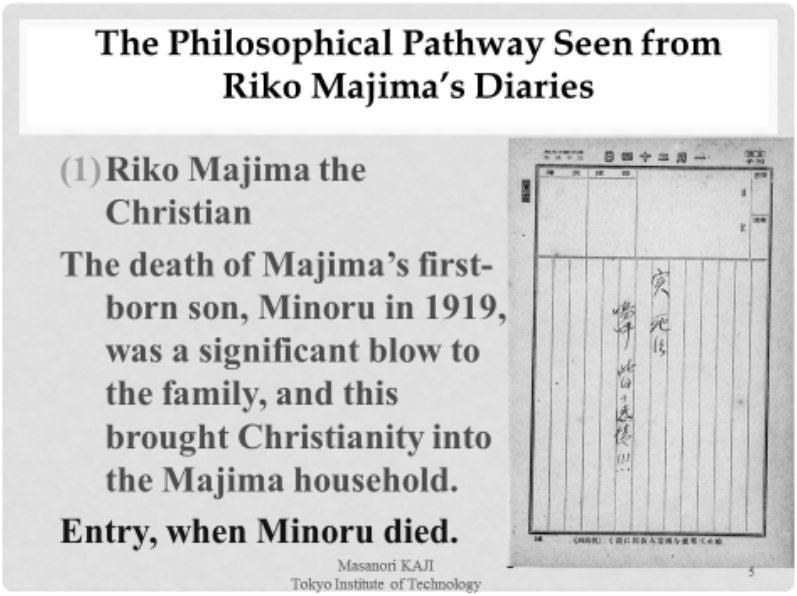
The Philosophical Pathway Seen from Riko Majima's Diaries

The preserved diaries begin in 1914, when Majima was thirty-nine years old, three years after his arrival in Sendai in 1911 when he was appointed a professor of chemistry in the College of Science at the newly established Tohoku Imperial University. The only content from the first existing year of 1914, with continuous entries is from January, followed by entries afterwards on only February 1st, August 23rd, and October 3rd. After this, there are no entries from 1915 or 1916. However, from 1917, with the exception of the year 1920, entries continue through to the first half of

[2] These are stored in the Tohoku University Archives: http://www2.archives.tohoku.ac.jp/, classified under "documents pertaining to Riko Majima" in the catalogue of individuals and related organizations (related to Tohoku University).

1944. Nothing remains from the diary for the period at the end of and immediately after World War II, from August 1944 to September 1948. After the war, there is material from October 1948, leaving a record of almost every day through to May 1959. From here it jumps to an entry from September 3rd of that same year, the last entry made by Majima's hand. Majima was eighty-four years old at the time, and would die three years later, on August 19th, 1962. In summary, Majima left a diary covering a time period of over forty years, from the time he was thirty-nine years old until he was eighty-four.[3]

From this, focusing primarily on Majima's Sendai-era diary, let us discuss the following three themes based on what we can gather from reading in relation to Majima's thoughts: (1) The Christianity of Riko Majima, (2) The Organizer Riko Majima, and (3) Riko Majima and the Imperial System.



[3] In his later years, in 1952, Majima visited Sendai, and stayed at Aone onsen in southern Miyagi Prefecture, where a student saw him write in his diary before turning in for the night. "Even now, I still remember him writing in his diary before he went to sleep" (Posthumous collection, 1970, p. 485).

1) Riko Majima the Christian

Considering the second half of Majima's life, it is important that he had converted to Christianity in the middle of his life. Although four children were born to Majima and his wife,[4] his eldest daughter Kimiko died at the age of two, and his first son, Minoru, died aged seven. Majima's second son, Yukio, and his third son, Toshimitsu, lived to adulthood. The death of Majima's first-born son, Minoru in 1919, was a significant blow to the family, and this brought Christianity into the Majima household.

When Majima converted to Christianity, he chose the Anglican Church perhaps arbitrarily, based on personal experience and relationships. It was mostly due to the fact that the staff of the Anglican-Episcopal Church of Japan Kindergarten, which their son had been attending, brought the Majima family great comfort.

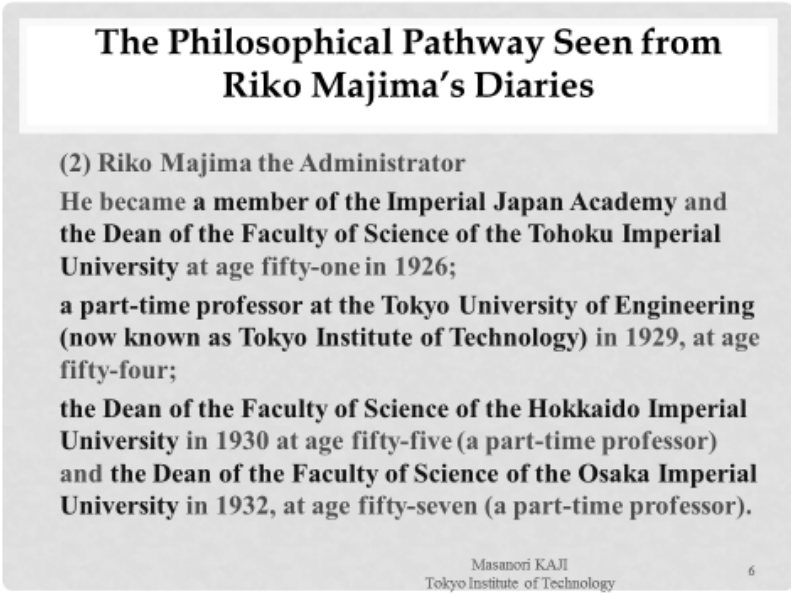
Majima has left behind a few materials pertaining to lectures where he discussed the relationship between religion and science. Two such documents are contained within his posthumously collected memoirs: "Shinko to Kagaku" (Faith and Science) from 1925, during his Sendai era (Posthumous collection, 1970, pp. 244-249); and, from 1951 after the war, "Kagaku To Shukyo" (Science and Religion, Ibid, pp. 345-356) given as a commemorative speech during Tohoku University's graduation that year.

2) Riko Majima the Administrator

Majima's conversion in the wake of Minoru's death became the turning point in a life that had been devoted to research. After the "baptism-induced middle-age mental remodeling" (Posthumous collection, 1970, p. 36) that Majima experienced in his mid-forties, he began to be more involved in university administration in addition to research. He became a member of the Imperial Japan Academy and the Dean of the Faculty of Science of the Tohoku Imperial University at the age of fifty-one in 1926; a part-time professor at the Tokyo University of Engineering (now known as the Tokyo Institute of Technology, our university) in 1929, at the age of fifty-four; the Dean of the Faculty of Science of the Hokkaido Imperial University in 1930 at the age of

[4] According to the recollections of Majima's nephew, soon after they married, Majima's wife became pregnant, but had a miscarriage while Majima was studying abroad (Posthumous collection, 1970, p. 406).

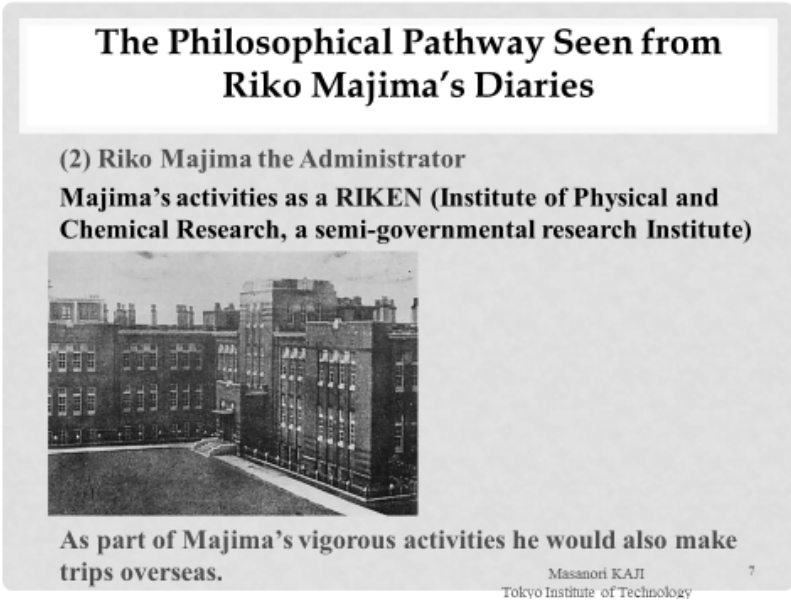
fifty-five (a part-time professor) and the Dean of the Faculty of Science of the Osaka Imperial University in 1932, at the age of fifty-seven (a part-time professor). In this way he acquired a series of positions of academic administrative responsibility. Of course, Majima had reached an appropriate age for such appointments, and also, at the transition between the 1910s and the 1930s, institutions of higher education were entering a period of expansion; Majima described himself: "If I had not been baptized and undergone such personal change, probably I would not have been called on for such responsibilities. And even if I had been called on for them, I would not have wanted to take them on" (ibid.).



These jobs were geographically distant from each other. One might think that those part-time professorships would only be nominal, but Majima's diary indicates that he traveled from location to location to give lectures and host conferences in a manner appropriate to such appointments.

Majima's activities as a RIKEN (Institute of Physical and Chemical Research, a semi-governmental research Institute) researcher were also important. Majima was employed as a member of staff at RIKEN on September 1st, 1917, only a short while after its establishment on March 20th, 1917. From January 1921 he became a senior researcher and

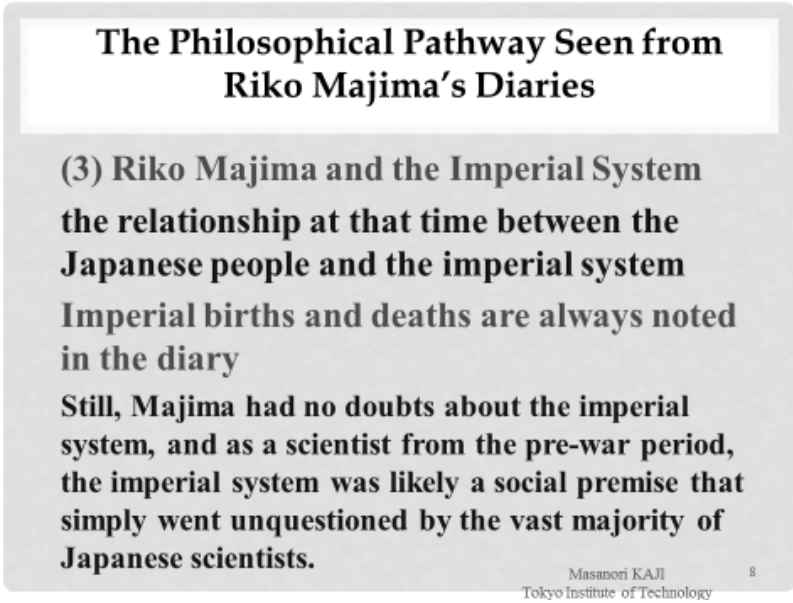
presided over his own laboratory. Thereafter, until he retired on June 30th, 1945, Majima retained his own laboratory at RIKEN.[5] As his diary shows, whenever Majima travelled to Tokyo, he would always stop at RIKEN and meet with staff members attached to his laboratory.



As part of Majima's vigorous activities he would also make trips overseas. For example, he was ordered to travel to Europe and America to attend the fifth general assembly of the International Union of Pure and Applied Chemistry (IUPAC) in 1924 as a representative of Japan. Majima's diary describes the activities of his daily itinerary, which would put any backpacker to shame.[6] It was precisely because of this energy that Majima was able to become a central figure in the expansion of Japanese chemistry between the 1910s and the 1930s.

[5] According to the RIKEN memorial room.

[6] Since Majima wrote of his travels in his diary in detail, it may be possible to complete an analysis of "Majima the traveler."



3) Riko Majima and the Imperial System

Reading Majima's diary raises another point, in that it offers an understanding of Japanese scientists from before World War II, one that is difficult to notice from simply reading articles: the relationship at that time between the Japanese people and the imperial system. Majima's diary contains entries related to the imperial family that use extremely honorific and deferential language.

Imperial births and deaths are always noted in the diary,[7] and, whenever there was a special occasion, such as the Emperor's birthday or Kigensetsu

[7] For example, on December 6th, 1925: "At 8:30 pm, the imperial princess is born." This referred to Emperor Showa's first daughter Shigeko Higashikuni (1925-1961). On March 6th, 1928: "Naishinnō Yuko Hisanomiya–born September 10th last year–passed away at three o'clock this morning. We will mourn her death." This referred to Emperor Showa's second daughter, who died prematurely of sepsis at six months of age. On December 23rd, 1933: "This morning at 6:39, Emperor Showa's son was born. The whole nation celebrates." This referred to Emperor Showa's first prince, Akihito. Majima dutifully recorded imperial events in this fashion in his diary.

(February 11th, the day commemorating the enthronement of the first emperor, Jimmu), or the coronation of Emperor Hirohito, there was always a celebration and a ceremony at the university, which faculty and students attended. Various kinds of ceremonies, such as an imperial visit to the university, or the reception of a decoration,[8] or even an audience with the Emperor himself,[9] gave opportunities for university professors to be aware of the presence of the imperial system daily.

Majima was one of the most eminent pre-war Japanese chemists. He was deeply involved in academic administration, and it seems that his sensitivity to society at large was higher than that of his peers due to his faith in Christ. Still, Majima had no doubts about the imperial system, and as a scientist from the pre-war period, the imperial system was likely a social premise that simply went unquestioned by the vast majority of Japanese scientists.

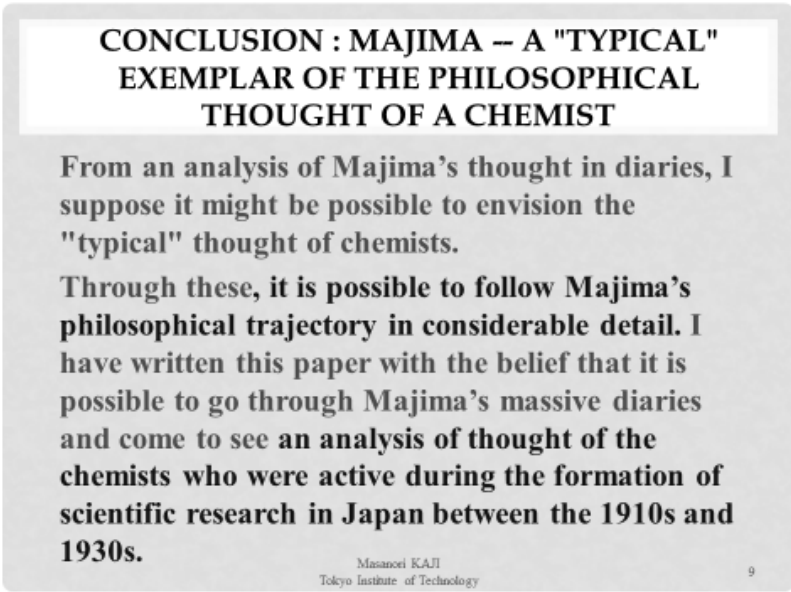
Conclusion: Majima–A "Typical" Exemplar of the Philosophical Thought of a Chemist

Riko Majima was a top-level chemist produced by the modernization of Japan during the Meiji restoration. This paper has examined what such a chemist may have been thinking. Although Majima was a superlative chemist, we find that he did not really engage in any special sort of philosophical thought. Nevertheless, this "typical" chemist had an influence on colleagues and students, peers and successors. This influence developed into a type of "thought," one characteristic of the population of chemists as a whole. Therefore, from an analysis of Majima's thought in Diaries, I suppose it might be possible to envision the "typical" thought of chemists. There are many chemists who leave behind no personal writings besides papers, textbooks, and abstracts, etc. Fortunately, Majima was a chemist who left behind not only autobiographical texts but also a

[8] During his Tohoku Imperial University era in Sendai, Majima was awarded: the Order of the Sacred Treasure, fifth class on January 1st, 1918; the Order of the Sacred Treasure, third class on January 8th, 1923; and the Order of the Sacred Treasure, second class on May 16th, 1930. Masataka Ogawa (1865-1930), who served as president of Tohoku Imperial University, was awarded the Order of the Rising Sun, second class on July 20th, 1930, immediately after his death, following the application from Tohoku Imperial University in which Majima was instrumental.

[9] On November 8th, 1932, Majima and his wife met with the Emperor at Shinjuku Gyoen. It is unknown what kind of events took place.

voluminous personal diary collection. Through these, it is possible to follow Majima's philosophical trajectory in considerable detail. I have written this paper with the belief that it is possible to go through Majima's massive diaries and come to see an analysis of thought of the chemists who were active during the formation of scientific research in Japan between the 1910s and 1930s.



GHOST SCIENCE: WRITING THE HISTORY OF 21ST CENTURY SCIENCE

JORGE C. G. CALADO[1]

Taking as a starting point the correspondence of Michael Faraday, and prompted by a few books that hide or suppress crucial images, the author ponders a present in which historical sources have migrated to the ether, where they risk being deleted at the click of a mouse. For better or worse, our past has gone online; it can be sometimes retrieved, but it is also liable to be corrupted and is easily destroyed. Is the digital format the modern equivalent of the fire that destroyed the Ancient Library of Alexandria in 48 BC? Another pitfall for the historian of science is the current generalization of fraud, for personal gain, in scientific research. The scientific world has its own equivalent to the infamous financial world.

1. Introduction

I begin with a confession: I am not a historian of science; I am–or rather, was–a practising physical chemist, experimental as well as theoretical, my subject being molecular liquids, *i.e.* made of relatively small molecules. But I have always been addicted to the history of science. I probably became a scientist because the first books I read were biographies of inventors and scientists. By the age of seven or eight I had read not one but three biographies of Madame Curie and had seen the movie starring Greer Garson and Walter Pidgeon. In the 1980s I reviewed books on the history and philosophy of science for the *Times Literary Supplement*. At Cornell University I met and learned a lot from L(eslie) Pearce Williams, the founder of Cornell's programme in the History and Philosophy of Science and Technology and a distinguished biographer of Michael Faraday[1].

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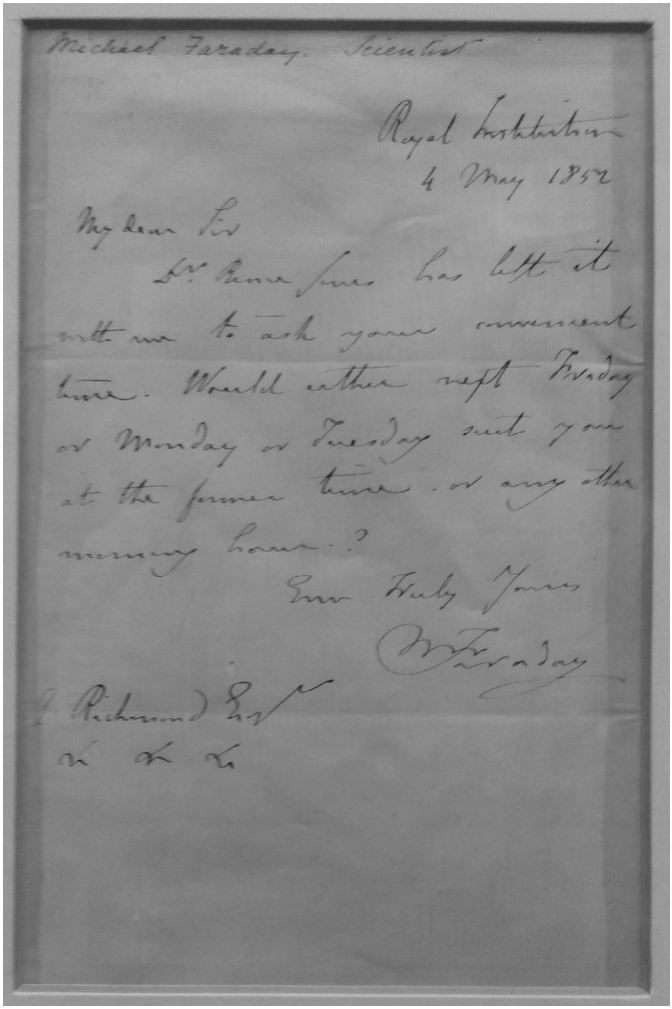
Sadly, he left us in February 2015; I would like to dedicate this article to his memory.

Faraday had been one of my heroes since childhood, so much so that while I was a PhD student at Oxford in the late 1960s I bought from a London dealer in Charing Cross Road a short, autographed letter of his (Figure 1).


Michael Faraday. Scientist

Royal Institution
4 May 1852

My dear Sir

Dr. Bence Jones has left it with me to ask your convenient time. Would either next Friday or Monday or Tuesday suit you at the former time or any other morning hour?

Ever Truly Yours
M Faraday

1 Richmond Ter
Whitehall

Figure 1. MICHAEL FARADAY, Autograph letter, 4 May 1852. Author's personal collection

Many years later, when I showed it in Lisbon to Sir George Porter (later Baron Porter of Luddenham), then the director of the Royal Institution of Great Britain, I was surprised to learn that it was unknown to Frank James, who was half-way through his cyclopic task of editing for publication the more than 5000 extant Faraday letters from over 260 archives around the world. The omission has now been rectified and the letter appeared in print for the first time in the sixth and last volume of "The Correspondence of Michael Faraday" (1991-2012).[2]

In 2011, the International Year of Chemistry, I published–alas, in Portuguese–"Let There Be Light", a History of Chemistry Through Everything, where Everything meant all the other sciences, literature, painting, music, theatre, photography, cinema, religion, philosophy, economics, politics, theory of ideas and so on (Figure 2).

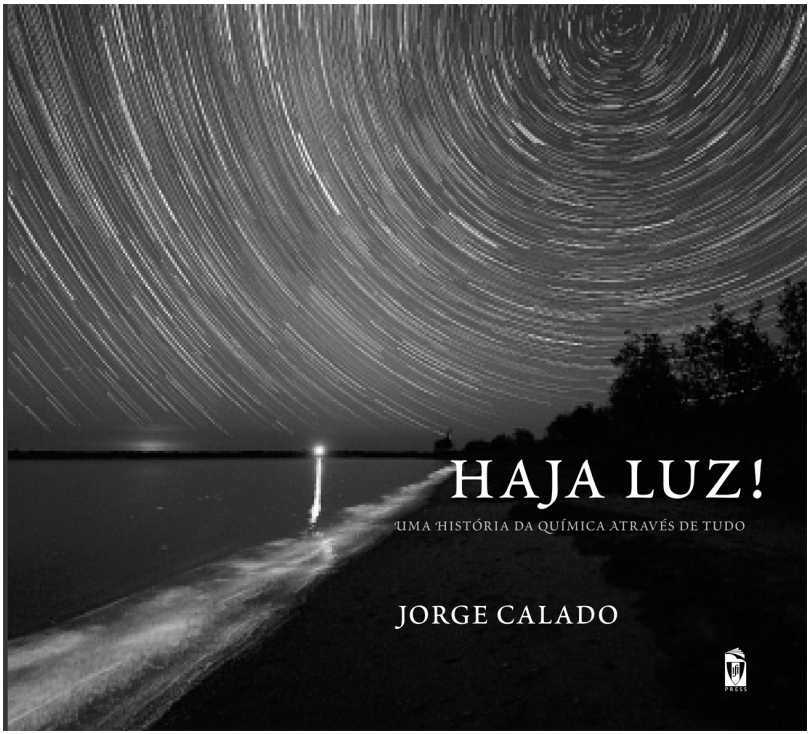


Figure 2. JORGE CALADO, *Haja Luz!−Uma História da Química Através de Tudo*, 2011

I had found, through practice and experience, that the best way to capture the interest of my students in abstract matters like statistical mechanics, group theory, etc., was to spice up the lectures with biographical details of the scientists and/or through an assortment of parallels with the arts. As a teacher I have always believed that one ought to humanize science and teach it through history, without hiding the pitfalls, U-turns and errors that scientists make while trying to push the boundaries of their subject. The progress of science is anything but linear. One learns by trial and error.

2. An Electrifying Man

Michael Faraday (1791-1867) is a good role-model for any teacher. He has aptly been described as an electrifying as well as a magnetic person (Figure 3).

Faraday was Mrs. Thatcher's favourite scientist and between 1982 and 1996 his bust (by Matthew Noble) was prominently displayed in the entrance hall at Number Ten, Downing Street. One of the most famous men in the world, Faraday managed to show that his experiments in the laboratory and his work for religious and state institutions were interconnected. Reason and emotions, beliefs and convictions, work and leisure are all part of the fabric of life. Faraday was a very private man, but he came to represent the idea of public science. In this International Year of Light, I would like to mention Faraday's work for the Corporation of Trinity House, the body responsible for the installation, maintenance and repair of Britain's lighthouses in England and Wales. He worked for the Corporation as a scientific advisor for over 30 years (from 1836 to just before his death in 1867), taking on tasks like analysing the painting of lighthouses or supervising the conversion of some to electric power. He always felt a moral imperative to use scientific knowledge to save lives, and he thought that he could achieve this by improving the efficiency of those installations.

The over 5000 letters that remain–most likely the proverbial tip of the iceberg–are invaluable primary sources, providing the reader with keys to the mystery of how Faraday's mind worked. He corresponded with people from every walk of life, at home and abroad, young and old: other scientists, of course, but also royalty, poets, painters, actors, the common man and woman; among them that “Enchantress of Numbers”, Ada Lovelace (Lord Byron's daughter), an expert on number theory and a pioneer in what would become known as computer programming (but which she called “poetic science”), who had a crush on him. Like all the

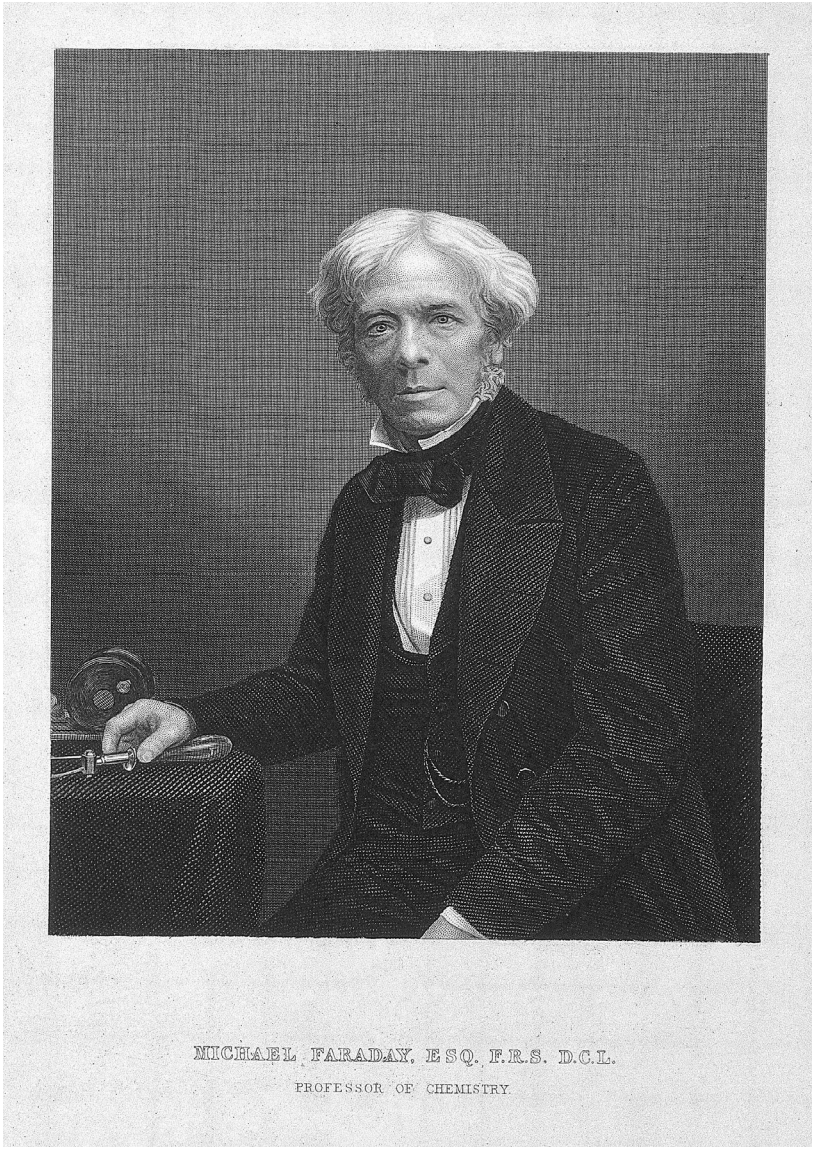


Figure 3. Michael Faraday, 1791-1867

great scientists, Faraday had a very inquisitive mind, and his letters teem with interrogations and question marks. Of course, many were written to answer scientific queries from colleagues, friends, his beloved nieces or members of the public, who contacted him seeking explanations or solutions for specific problems. Faraday was a man of infinite curiosity. He usually answered a question with a battery of other questions, sometimes dozens of them in a single letter. It was his habit to frame careful, practical responses, often stressing the limits of his expertise or suggesting where better answers could be found. Sometimes he would complain saying that he found himself engaged in everybody's business but his own, but he was a generous man.

3. Oceanic Feeling

Call me a romantic, but I admire the idea of a scientist dedicated to spreading the good news of his discoveries and of helping others to solve their problems. Science is about tying up diversity into an integrated whole, showing the similarities between different things, mending and unifying what appears broken up and fragmented. Faraday did just that with electricity and magnetism, and in a seminal course of lectures delivered in 1859 before a juvenile audience at the Royal Institution, "On the Various Forces of Nature and their relations to each other", he tried to extend the analogies to cohesion (intermolecular forces), chemical affinity and gravitation.[3] One of the most precious books in my personal library is this copy of the first edition of "Various Forces of Nature" (1860) in its original and beautiful binding in pristine condition. Will our diskettes, CDs and memory sticks be still available and in good working order in 150 years' time? Certainly not: they won't even last the time of a single generation!

Creation–whether artistic or scientific–generates that larger-than-life oceanic feeling of limitlessness, a psychological term introduced by Romain Rolland in connection with Religion, and later popularized (as *Ozeanisches Gefühl*) by Sigmund Freud in his books "The Future of an Illusion" (1927) and "Civilisation and its Discontents" (1930).[4] The pursuit of scientific knowledge in the laboratory or study room may often be a lonely activity, made bearable by the support of a good wife, husband or assistant, but men and women of science have always tried to overcome geographical, ideological and cultural barriers in search of a wider understanding for their work. The urge to communicate, share and validate whatever has been created or discovered is unquenchable. It was this urge