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Chemistry and History

Edvard Immanuel Hjelt (1855–1921): Finnish Chemist and Historian of Chemistry

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He was an excellent judge of persons, and his power to inspire confidence and influence people served him well in his teaching, administrative, political, and diplomatic capacities.

Although today unjustly neglected abroad and often even in his native land, Edvard Immanuel Hjelt (1855–1921), was an exceptionally gifted, dedicated, and multifaceted individual who made important contributions to chemistry, the history of chemistry, politics, and the management of national and international affairs. Little information about him is available in English. The present article supplements the only two English sources available [1, pp 66–83; 2] and makes this chemist-statesman better known to those chemists and historians who do not read Swedish or Finnish.

In this section we present articles by leading scientific historians that chronicle the important events, persons, and publications that make up the rich history of chemical science. The history of chemistry, of course, has taken place against the background of world history, and the articles in this section often make that very clear. Chemists and their research are always influenced by current events. These articles are intended to describe the setting in which important discoveries occurred and to humanize their discoverers.

—Clifford LeMaster, Editor in Chief

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Early Life [3–9]

Edvard Immanuel Hjelt (Figure 1) was born on June 28, 1855 at the Hurri estate in the parish of Vihti (Swedish, Vichtis) near Helsinki. He was the second of six sons and the fourth of eleven children of Otto Edvard August Hjelt (1823–1913), Professor of Pathological Anatomy and Forensic Medicine at the University of Helsinki, and Yolanda Aurora Hjelt (née Thuneberg). His parents were very religious, and his early education, like that of his siblings, was almost completely in the hands of his mother, "an abundantly gifted woman with whom the education of the heart was predominant" (Quotations are from Hjelt's book *Autobiographical Sketches from Childhood and Youth* [3b].) In contrast to his mother's altruistic, impulsive nature, his father was "a critical man of reality and deliberation," who "was always busy and was rarely able to devote himself to the family."

From September 1, 1862 to June 5, 1872 young Edvard attended a private college preparatory grammar school in Helsinki, where, he later admitted, he was no "shining light." He exhibited an early passion for literary activity, and, while in the lower grades, he edited a handwritten newspaper *Skogsjungfrun* (The Forest Maiden), only a few issues of which appeared and which had only ten subscribers. Later his father gave him a small hand printing press, and, together with his older brother Otto Jonatan (1853–1918) and one of Otto's friends, he published a newspaper *Månadsbladet* (The Monthly Paper). After being held back in the fourth grade on his father's request because he was the youngest in the class, he developed a great interest in learning and studying. Greatly impressed by his reading of Benjamin Franklin's *Autobiography*, he resolved to improve himself by recognizing his deficiencies and striving to overcome them as Franklin had done. By the time of his graduation at the age of not quite seventeen, he was the second highest student in the class.

University Studies, Early Travels, and First Teaching Position [2–9]

In the Fall of 1972 Hjelt entered the Physics-Mathematics Section of the University of Helsinki (in Finnish, *Helsingin yliopisto*; in Swedish, *Helsingfors Universitet*; Finland, which was once a Swedish grand duchy, is largely bilingual) where he made natural history, especially zoology, his main course of study with the intention of later studying medicine like his father. Fascinated by the chemistry lectures of Professor Johan Jacob Chydenius (1836–1890) [1, pp 62–66; 10–12], he shifted his interest to this subject, and on May 7, 1875 he passed the examination for his master's degree

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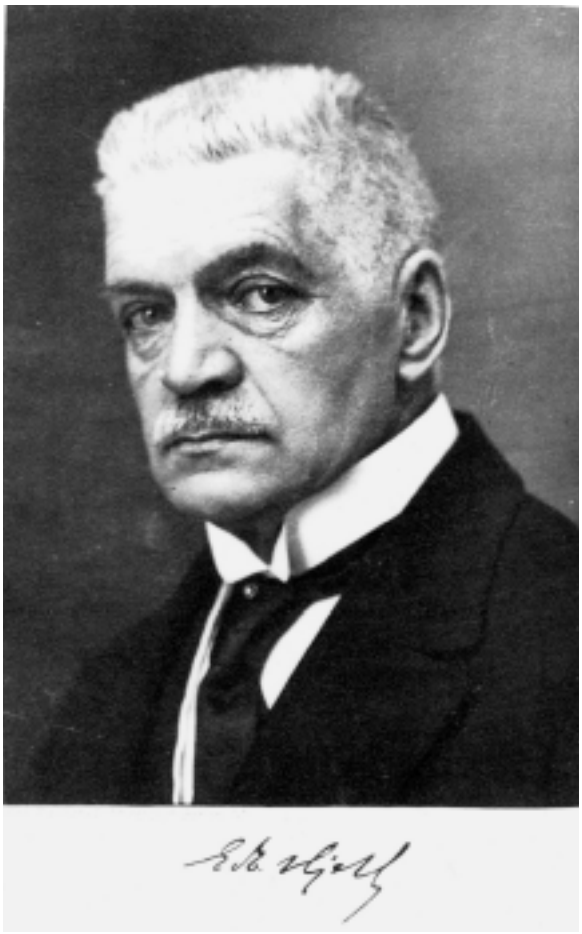

FIGURE 1. EDVARD IMMANUEL HJELT (1855–1921), LAST PORTRAIT, TAKEN IN 1918 [3b].

with chemistry, zoology, and botany as his main subjects. He became engaged to Ida Sofia Åström (1856–1930) on May 15, 1875, her nineteenth birthday: "A stormy, passionate feeling did not mark the relationship, which had gradually developed between us; rather it was a quiet inclination, growing more and more serious, which bound us together" [3b].

Although Professor Chydenius and Ernst Qvist (1839–1910) [1, pp 117–118; 13], Director of the Polytechnic Institute of Helsinki and proprietor of a small chemical plant, were pessimistic about the possibilities for establishing a chemical industry in Finland, Hjelt applied for and was awarded the Ekestubbe travel scholarship of 4,500 FIM for two years' study abroad in an applied science: "This decided, at least apparently, my career. I became not a technician, but a chemist" [3b]. From September 1875 to July 1876 he worked on chemistry and chemical technology at the Polytechnic

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Institute in Dresden with Rudolf Schmidt (1830–1898) and Heinrich Wilhelm Stein (1811–1889). This technical work, however, did not really interest him, and, suffering from homesickness, he counted the days until he could return to Finland on August 1, 1876.

On September 27, 1876 Hjelt departed for abroad again. From November 1876 to January 1877 he worked as an unpaid assistant at a sulfuric acid plant at Mügeln near Dresden, which resulted in his first publication—a study of the contamination of sulfuric acid by arsenic compounds [14]. On May 15, 1877 he was granted a master's degree in absentia, and in June and July he again worked with Stein in Dresden, finishing his studies in technical chemistry.

After returning home, Hjelt assumed his first teaching position, as a deputy teacher of chemistry at the Mustiala Agricultural Institute, where from January to October 1878 he taught agricultural chemistry, physics, mineralogy, and geology—subjects with which he was unfamiliar. In teaching he found an activity that really appealed to him, but in his own words, "I perceived...how deficient my scientific education was" [3b]. Hjelt then received a state stipend of 3000 FIM to study abroad in preparation for a career as a chemistry instructor. On October 15, 1878 he married his fiancée at the Gammelby courtyard in Tuusula (Swedish, Thusby) parish, and the following day the couple began their honeymoon trip. They traveled to Stockholm, Copenhagen, Hanover, Paris, and Bordeaux.

Because of Germany's leadership in organic chemistry, chemists from more marginally scientific countries (e.g., Wilhelm Ostwald of Latvia and Svante August Arrhenius of Sweden) traveled abroad for their advanced chemical training. Hjelt was no exception to this pattern. From December 1878 to May 1879 he worked with Johannes Wislicenus (1835–1902) at Würzburg, where he began a study of the amides of camphoric acid, the first work by a Finn on camphor and terpene chemistry, a field later extensively investigated by Finnish chemists. After his wife returned to Finland, Hjelt spent the summer in Adolf von Baeyer's (1835–1917) laboratory in Munich, where he met Emil Fischer (1852–1919) and Emil Erlenmeyer (1825–1909) and continued his work on camphoric acid.

Hjelt returned home in July, and on August 14, 1879 the first of his eight children (5 daughters and 3 sons), Esther Yolanda, was born [7]. On October 15, 1879 he

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publicly defended his thesis, *The Amides of Camphoronic Acid* [15], which, although based on the current, incorrect structure of the acid, still showed his independent powers of observation. He passed his licentiate examination on November 17, 1879, and on January 9, 1880 he was awarded his Ph.D. degree.

Academic Career and Textbooks [1, 3b, 7]

Having decided upon an academic career, on October 11, 1879 Hjelt was appointed to the position of *laborator* (first assistant) at the Chemical Institute of the University of Helsinki [16, 17], Finland's oldest and largest university (founded in 1640). The university played a significant role in fostering Finnish nationalism, and Hjelt was destined to make major contributions to this movement.

Professor Chydenius, although only 44 years old, had been stricken by an incurable, chronic illness, and Henrik Alfred Wahlforss (1839–1899) [1, pp 118–120], the only Docent in chemistry, had transferred to the Polytechnic Institute. Consequently, on October 25, 1879 Hjelt was appointed to present the chemistry lectures. Chydenius soon retired, and, beginning with the Spring 1880 semester, Hjelt was made responsible for all chemistry lectures and examinations; however, in order to be appointed to the chair of chemistry he would have to present a new dissertation.

Because his work on camphoric acid had awakened an interest in lactones, Hjelt worked on these anhydro-ring compounds in Helsinki and during the summers of 1880 and 1881 in the laboratory of Rudolph Fittig (1835–1910) at Strassburg. On March 22, 1882 he publicly defended his professorial dissertation, *Investigations on Lactones and Lactone Formation* [18], which applied the relatively new Le Bel–van't Hoff theory of the tetrahedral carbon atom to show that lactone formation is greatly influenced by the steric configuration of the molecule. On July 13, 1882 Hjelt, who was the only candidate for the professorship with a dissertation ready, was appointed to the chair of chemistry at the age of only 27, almost a record for the university. He was also the first professor of chemistry to be entirely devoted to organic chemistry, and he introduced the requirement of an experimental study for the M.Sc. degree [10].

For the next sixteen years, until he was appointed Rector in 1898, Hjelt's life was primarily dedicated to scientific research and teaching. A master of style and oratory, he was noted for his carefully prepared and elegantly delivered lectures and his

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FIGURE 2. "ARPPEANUM," THE UNIVERSITY OF HELSINKI CHEMICAL LABORATORY SINCE 1869. THE MAIN AUDITORIUM FOR CHEMISTRY IS IN THE SECOND FLOOR TO THE RIGHT. LITHOGRAPH, ABOUT 1870, NATIONAL MUSEUM OF FINLAND [1].

consideration for and empathy with students, most of whom were future medical students. His students celebrated his birthdays by singing on the wide staircase of the Arppeanum (Figure 2), the chemistry laboratory building named after Adolf Edward Arppe (1818–1894) [1, pp 53–62; 19], the chemistry professor who preceded Chydenius.

During this period Hjelt wrote a number of textbooks. Even before receiving his doctorate he wrote a *Short Description of the Progress of Chemical Analysis* (1879) [20]. His short text, *Principles of General Organic Chemistry* (1883), was well received and appeared in three editions in Swedish and was translated into German (1887) and English (1890) [21]. His popular work, *Chemistry* (1888), appeared in both Swedish and Finnish as a special volume in the Science Library of the Finnish Society for Popular Enlightenment [22]. Together with Ossian Aschan (1860–1939) [1, pp 83–91; 23–27], he wrote a comprehensive *Textbook on Organic Chemistry* (1893) [28], which went through four editions and was in use throughout Scandinavia until about 1930. At the request of Julius Wilhelm Brühl of Heidelberg, during the period of 1895

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to 1901, Hjelt and Aschan also published four new volumes of Henry Enfield Roscoe and Carl Schorlemmer's *Ausführliches Lehrbuch der organischen Chemie*, totaling about 4,000 pages and three additional volumes of about 2,500 pages [29]. In 1916 Hjelt wrote a short textbook, *Fundamentals of Chemistry*, for use in schools [30].

Aschan and Hjelt were also invited to contribute to the *Jahrbuch der Chemie*, edited by Richard Meyer (1846–1927). After Aschan had reported the progress in organic chemistry for 1908–1909, Hjelt assumed the task and reviewed the years 1910–1914. These reviews were comprehensive, each amounting to more than a hundred printed pages; they were also issued as separate reprints with printed wrappers [31].

Publications [1, 3b, 7]

Hjelt was a prolific writer with more than 200 publications to his credit [3c]. As he often remarked, he actually lived with a pen in his hand. The style and content of his historical works, especially his biographies, which were a major interest, were often artistic. He produced about 80 works on organic chemistry; 8 on inorganic, technical, and analytical chemistry; 15 on the history of chemistry; 6 memorial essays; 6 obituaries; 25 memoirs and political works; 16 academic speeches and essays; and many biographical and popular scientific essays.

Organic Chemistry

Hjelt published 45 articles on organic chemistry in the *Berichte der Deutschen Chemischen Gesellschaft* alone. Lactones, which formed the subject matter of his professorial dissertation, and the steric factors involved in their formation as well as their rates of reaction, were one of his major interests. Among his works in this area may be mentioned a monograph on the intramolecular dehydration of organic compounds [32], as well as his studies of the rate of lactone formation with γ-hydroxy acids [33], the relative rate of saponification of alkyl-substituted malonic acid esters [34], and coumarin formation [35], which demonstrated that the rate of lactone formation depends on constitution and configuration. In his monograph, *Über die Lactone* (1903), he summarized everything known about this class of compounds [36]. Other studies include those on the regularities between melting point and composition of organic compounds [37], *o*-xylenyl bromide and the synthesis of phthalic aldehyde [38], the action of aniline on esters in the presence of sodium [39], *sym*-diethylsuccinic acid [40], *sym*-dibromoacetone [41], and anhydride formation of substituted succinic

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acids [42]. He made the first chemical investigations of Ledum camphor or ledol [43] and established its composition as a tertiary alcohol, $C_{15}H_{23}OH$ [1, p 124].

Inorganic, Technical, and Analytical Chemistry

Hjelt's works in this area include studies of the contamination of sulfuric acid by arsenic compounds [14], the production of sulfuric acid in Germany [44], the determination of sulfur in iron pyrites [45], the determination of phosphorus in Finnish sea and swamp ores [46], the analysis of Finnish limestones [47], seawater in the southwestern Finnish archipelago and the Gulf of Bothnia [48], and the gray modification of tin [49].

History of Chemistry

After Hjelt became Rector of the University of Helsinki in 1899, the heavy, time-consuming responsibility of this administrative position prevented him from pursuing much work in the laboratory. In 1903 he published his last experimental work [40]. The history of chemistry, in which he had possessed a longtime interest, now became his main research topic in chemistry and the work for which he is best known today. He wrote a history of the Chemical Institute of the University of Helsinki on the occasion of the 250th anniversary of the university's founding [17]. Among his editions of correspondence are his books dealing with the letters of Friedrich Wöhler (1800–1882) to Jöns Jacob Berzelius (1779–1848) [50] and the Berzelius–Gustav Magnus (1802–1870) correspondence from 1828 to 1847 [51]. A related article dealt with French chemists as depicted by Wöhler in letters to Berzelius [52]. Hjelt's interest in the history of organic chemistry resulted in books on the development of the radical [53] and substitution theories [54].

These works served as forerunners of his *magnum opus* and main claim to chemical fame, viz., his comprehensive *History of Organic Chemistry from the Oldest Time to the Present* (1916) [55]. In this critically acclaimed volume he depicted in a captivating style the development of the various areas of organic chemistry whose historical relationship had not been considered previously. He dedicated the German version of this book to Adolf von Baeyer (1835–1917) on the occasion of his 80th birthday (October 31, 1915), and the book was the cause for Hjelt's selection as one of the relatively few honorary members of the Deutsche Chemische Gesellschaft in 1918, an honor that he particularly cherished. This book, in which Hjelt often let the great organic chemists speak in their own words, was almost complete when World War I

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broke out, and in its foreword he emphasized the international nature of science and asked [55, p ix]:

> Is it not to be hoped that when the waves of the great struggle have again abated, the bond of peaceful scientific work will again unite the civilized peoples in a common aspiration toward the same goals? And is it too bold to cherish the hope that above all the German researchers, regardless of what has happened, will strive to reestablish the interrupted relations?

Hjelt devoted many of his historical studies to chemists and chemistry in his native land, e.g., articles or monographs on the history of chemistry in Finland [56]; Johan Gadolin, the Finnish rare earth chemist [57]; Gadolin's views on combustion [58] and a selection of his works [59]; the Chemical Institute at the University of Helsinki [17]; and chemistry at the University of Helsinki in relation to the general development of science [60]. In addition to studies of Scandinavian chemists such as Carl Wilhelm Scheele (1882, 1913), Johan Jacob Chydenius (1891) [11], Adolf Edward Arppe (1895) [19], Adolf Erik Nordenskiöld (1903), Pehr Adrian Gadd (1909), and Gustaf Otto Mattsson (1915, 1920), he also wrote biographical articles and obituaries on more famous chemists such as Jean Baptiste Dumas (1884), Hermann Kolbe (1885), August Wilhelm von Hofmann (1892), August Kekulé (1896), Carl Remigius Fresenius (1897), Paul Schützenberger (1897), Victor Meyer (1897), Robert Wilhelm Bunsen (1899), Johannes Wislicenus (1902), Dmitrii Ivanovich Mendeleev (1907), and Friedrich Konrad Beilstein (1907). At the time of his death, he left behind an unpublished historical manuscript, *Die Schulen der organischen Chemie im 19. Jahrhundert* (The Schools of Chemistry in the 19th Century) (1921), which he had contracted to write for his publisher, F. Vieweg und Sohn in Braunschweig.

Administrative and Governmental Duties [1, 3b, 7]

Hjelt was appointed auditor of the university's accounts (1888–1896), Vice Rector (1896–1899), and three terms as Rector (1899–1908). It is a tribute to Hjelt's willpower and self-control that he was able to discharge these duties, let alone carry out research on the history of chemistry, during this time of conflict. Beginning in 1899, the previously peaceful collaboration between Russia and its semi-autonomous grand duchy of Finland changed to violent confrontation, replete with student strikes and demonstrations, when the Czarist régime attempted to "russianize" Finland, with, e.g., introduction of Russian postal, toll, and monetary systems and military

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conscription. During his tenure as Rector, Hjelt skillfully managed to pacify the students and faculty with empathy and understanding while simultaneously preventing the government authorities from taking stronger, more repressive measures. Because the university had been regarded for more than a century as “Finland's heart,” the importance of Hjelt’s contributions to his country cannot be overemphasized. He chronicled his eventful years as Rector, Vice Chancellor, and Senator (1899–1917) in a book of memoirs [61]. He “performed greater services to the University than anyone since its founding” in 1640 [1, p 83; 3b; 10].

In 1906 Hjelt entered the government as Assistant Head of the Board of Education, and in 1908 he was appointed Vice President of the Imperial Senate’s Economic Department, a position corresponding to Prime Minister. In 1909 he was appointed to a new second professorship of chemistry, which he held until 1910 when he was appointed the university's Vice Chancellor. He played a prominent role in politics and was active in the struggle for Finnish independence, which he chronicled in his book, *Finland's Independence, From Dream to Reality* [62]. In January 1918 Hjelt was appointed Finnish Minister in Berlin, where he obtained recognition for the new republic.

In July 1918 Hjelt had an audience with the Kaiser and conferred Finnish decorations on the Kaiser, Hindenburg, and Ludendorff at the Germany army headquarters at Avesnes. After the German revolution Hjelt helped Ludendorff escape from Germany, an action for which he was reproached by his government and by Mannerheim, the new acting head of Finland. His Germanophilism and Francophobia reduced his effectiveness as a postwar diplomat, and, after taking three months’ leave, he was dismissed in May 1919 from the Finnish diplomatic service. After his recall to Helsinki, he was appointed Acting Chancellor of the University of Helsinki. In addition to his administrative duties, he devoted himself to editing his memoirs. He spent his summers in Germany. At Bad Mergentheim in Württemberg where he had gone for his health he suffered a burst gall bladder, which caused peritonitis. Despite an operation, he died of heart failure on July 2, 1921 at the age of sixty-six.

Conclusion

Despite his courteous manners, Hjelt was taciturn, and his reticence was interpreted as coldness by those who did not know him well [1, p 68; 3b, pp 184–185]. He trusted

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FIGURE 3. HJELT AT THE 200TH ANNIVERSARY CELEBRATION OF THE BERLIN ACADEMY OF SCIENCES WITH FAMOUS CONTEMPORARY CHEMISTS 1900 (FROM LEFT, FRONT ROW: JACOBUS HENRICUS VAN'T HOFF, FRIEDRICH KONRAD BEILSTEIN, WILLIAM RAMSAY, DMITRII IVANOVICH MENDELEEV, ADOLF VON BAEYER, AND ALFONSO COSSA; BACK ROW: ALBERT LADENBURG, SOPHUS MADS JØRGENSEN, EDVARD IMMANUEL HJELT, HANS HEINRICH LANDOLT, CLEMENS ALEXANDER WINKLER, AND JOCELYN FIELD THORPE.

few persons, but he was affectionate and unselfish to those who had earned his trust. He was an excellent judge of persons, and his power to inspire confidence and influence people served him well in his teaching, administrative, political, and diplomatic capacities. A deeply religious man, he held Sunday school for the children of servants and laboratory workers, and on Christmas Eve he would distribute fresh bread to the families of laboratory servants and to hungry persons in the street. Mutual attractions with idealistic women occasionally led to intense platonic relationships.

Hjelt was a member of many Finnish and foreign scientific societies [3b, pp 70, 189–190; 7] (Figure 3). Together with Aschan and Qvist, in 1891 he founded the Finnish Chemical Society (Finska Kemistsamfundet–Suomen Kemistiseura), the ninth oldest chemical society in Europe and the eleventh oldest in the world [1–4; 5, pp 137–139, 144] (Figure 4). He was extremely active in this organization, being Chairman five times between 1892 and 1906 and Vice Chairman in 1920. He was dignified in leading

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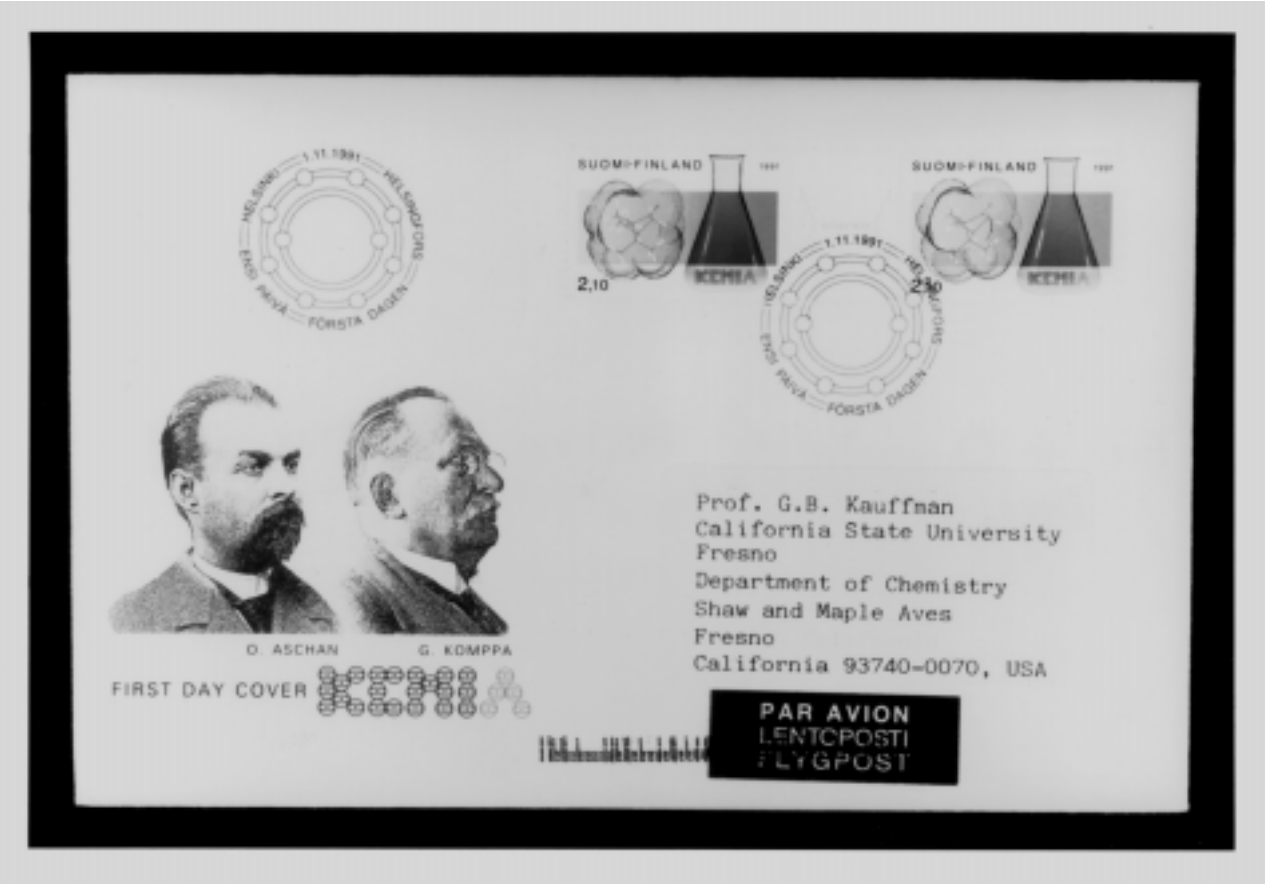

FIGURE 4. FIRST-DAY COVER ISSUED ON NOVEMBER 1, 1991 TO COMMEMORATE THE CENTENARY OF THE FOUNDING OF THE CHEMISTS' CLUB AT THE HELSINKI UNIVERSITY OF TECHNOLOGY AND THE FINNISH CHEMICAL SOCIETY [63].

the meetings and often presented lectures and interesting memorial speeches on renowned chemists. He was made an honorary member in 1915. He was a foreign member of the Swedish Academy of Sciences (1899) and, as previously mentioned, an honorary member of the Deutsche Chemische Gesellschaft (1918). His thorough study of the apothecary system in Finland and abroad (1910) led to honorary membership in the Association of Apothecaries in Finland and the Pharmaceutical Society in Stockholm. Concerned with nonscientific and cultural matters, he was active in such organizations as the Finnish Society for Popular Enlightenment, the Seaman's Mission, and the Red Cross. His election to honorary membership in student organizations attested to his recognition by students. He was awarded decorations and medals from Finland, Sweden, Denmark, Germany, and other countries.

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In the words of Finnish historian of science Robert Tigerstedt [5, p 22]

> Edvard Hjelt was a man of whom our country can with good reason be proud, a man whose memory, even in distant future days, will be preserved in grateful recollection.

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