Zapomenutý matematik Henry Lowig (1904–1995)

IV. English Summary

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ENGLISH SUMMARY

The main aim of this book is to inform the reader about the life of Henry Lowig (1904–1995), a mathematician and teacher, whose life story paralleled the evolution of the Czech nation during the 20th century. Henry Lowig initially devoted his time to differential and difference equations, linear algebra and functional analysis; later he primarily focussed on modern algebra, specifically, structural theory. He published 24 articles, 3 preliminary reports and 40 reviews. He has been largely forgotten by the Czech mathematics community, because he never wrote any textbooks or monographs, he has no disciples or followers in the Czech Republic, his professional work was written only in German and English, and he belonged to ethnic and religious minorities.

This book is based on the documents about the Lowig's life and work that are stored in archives in Prague, Liberec and Pardubice (Czech Republic) and Sydney (Australia). Some information was gathered through family memoirs and memoirs of Lowig's colleagues and friends.

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Heinrich Löwig's family – parents and sister

Henry Lowig was born on 29 October 1904 at Královské Vinohrady in Prague. The name on his birth certificate is Jindřich František Josef Löwi. In his younger years he was mostly known by his German name Heinrich Franz Josef Löwig and, to his family, as Heinz.

Löwig's birth certificate denotes him a Catholic of German nationality. His father was Heinrich Löwi (1874–1944), a professional engineer, and his mother was Katharina Löwi, born Chwoyka (1881–1962). His father was born on 10 September 1874 in Eidlitz (today called Udlice) in the district of Chomutov. His parents were Josef Löwi, a Jewish shopkeeper, and Flora (born Kohn) of Tuchorzic, who was the daughter of Abraham and Johanna Kohn. Heinrich Löwi had four siblings – Albert (?–1943), Berta (?–?), Marie (?–1944) and Anna (?–1944).

From 1884 to 1898 Löwi studied chemistry fulltime at the German Technical University in Prague. He was amongst the top students, generally completing examinations with excellent grades. In 1897 he wrote his first state examination and in the following year the subsequent state exam, thereby completing his studies.

In 1904, Löwi gained employment as a permanent public servant and was appointed *Postal Construction Adjunct* at the Prague Postal Directorate. On 6 September 1904 just before his 30th birthday, Löwi was christened at St. Ludmila Church at Královské Vinohrady, Prague. In the same church on 12 September 1904, in spite of his parents' disapproval, he married Katharina Chwojka,

who was born on 7 April 1881 in Scheles at Podbořany (today Žihle). Katharina was the daughter of Václav Chwojka (born 3 March 1834), a tenant farmer in Scheles and Theresa (Tereza) born Lüftner on 10 April 1841. On her father's side Katharina was Czech and on her mother's side German. She considered herself a German national and did not speak Czech very well. On 29 October 1904 they had a son Heinrich and on 28 October 1906 they had a daughter Anna (1906–1987).

In 1905, approval was given to Löwi to change his surname to Löwig under the Imperial Bohemian Governorship Ordinance and Archbishop's permission. The name change applied to the whole family. From 1904 to 1907 the family lived in Prague, then from 1907 to 1920 they lived in Liberec (Reichenberg in German). After this first period in Liberec, the family moved quite often. They lived in Pardubice (1920–1930), then again in Liberec (1930–1938), and finally again in Prague from 1938.

Heinrich Löwig started out as an administrative officer at the Posts and Telegraphs Directorate in Prague and then from 1907 to 1920 held similar positions in Liberec. His first appointment was as *Bauadjunkt* [Construction Adjunct] in the *Telegraph Line Section*; next he was *Baukommissar* [Construction Superintendent] and then *Bauoberkommissar* [Senior Construction Superintendent] at the *Telegraph Construction Authority*. Later he was appointed *Baurat* [Construction Counsel]. In 1920 Löwig was transferred by the Ministry of Posts and Telegraphs from Liberec to Pardubice. Shortly after that he was appointed *Chief Technical Construction Counsel* at the *Pardubice Posts and Telegraphs Directorate*. On 1 November 1930 Löwig retired and the Löwigs returned to Liberec where they lived until 1938.

It is of interest that Heinrich Löwig was an active member of the Liberec faction of the *Deutsche sozialdemokratische Arbeiterpartei* [German Social Democratic Workers Party]. During 1919 and 1920 he sat on a number of Municipal Council committees and boards overseeing the operations of municipal services and the management of city finances.

Heinrich Löwig's high school and university student years

Young Heinrich Löwig was first a pupil at the German primary school in Liberec. Then from 1915 to 1923 he was at the *Deutsche Staatsgymnasium in Reichenberg* [German State Grammar School in Liberec]. Initially an average student, from 1919 he began to excel and became one of the top students. On 19 June 1923 he matriculated with distinction, which qualified him to attend any institution of higher learning.

At the beginning of the 1923/24 academic year, Löwig enrolled at the *Naturwissenschaftlichen Fakultät der Deutschen Universität* [Faculty of Science of the German University in Prague]. He attended lectures in mathematics, physics, astronomy and chemistry. Because he was considering a teaching career, he also enrolled in courses in pedagogy, psychology, German language, literature, history, etc. Amongst his professors were Georg Alexander Pick

(1859–1942), Ludwig Berwald (1883–1942), Arthur Winternitz (1893–1961), Karl Mack (1882–1943) and Karl Löwner (1893–1968) (all of whom lectured in mathematics), Reinhold Fürth (1893–1973), Paul Georg Funk (1886–1969) and Philipp Frank (1884–1966) (all of whom lectured in physics), Adalbert Prey (1873–?) (astronomy) and Alfred Kirpal (1867–1943) (chemistry). Löwig attended up to 40 hours per week of lectures, seminars, tutorials and laboratories. In 1928, he was awarded a scholarship of about 700 crowns from the Bernard Bolzano Fund which was set up to support talented mathematics students.

In 1928, the Faculty of Science of the German University in Prague granted Löwig approval to teach mathematics and physics in German language high schools. During the same period he left the Catholic Church and pronounced himself "without religion". From the autumn of 1927, H. Löwig worked towards his doctorate. On 6 December 1927 he handed in his doctoral thesis entitled *Über periodische Differenzengleichungen* [On periodic difference equations] and on the basis of Pick's and Berwald's recommendations and his oral examinations in mathematics and astronomy he obtained the doctorate degree on 9 June 1928. A short extract of his doctoral thesis was published under the name *Über periodische Differenzengleichungen* [On periodic difference equations] in the journal Lotos [L1].

Heinrich Löwig's early pre-war career

From 1928 to 1930, Heinrich Löwig carried out his obligatory army service in the Cavalry Regiment No. 3 at Nové Zámky (now in Slovakia) and then he was transferred to the Infantry Regiment No. 25 at Lučenec (now in Slovakia). On 29 March 1930 Löwig was released from the eighteen-month full-time regular service with the rank of lance corporal. During 1931 and 1932 he participated in two prescribed army exercises; he was excused from another two. Later, on 25 September 1938 he was called to active service as part of the general mobilisation.

On 13 November 1930 Löwig was appointed *Hilfslehrer* [Assistant Teacher] at the *Deutsche Staatsrealgymnasium in Prag II* [German State Grammar School at Prague II] where he worked until 31 January 1931. On 17 April 1931 he was appointed *Assistant Teacher* at the *Deutsche Staatsgymnasium in Reichenberg* [German State Grammar School in Liberec] where he was until 14 May 1931. On 1 May 1931, he was appointed *Wissenschaftliche Hilfskraft* [Graduate Teaching Assistant] in the *Mathematisches Institut der Deutschen Universität in Prag* [Mathematics Institute at the Faculty of Sciences of the German University in Prague]. He remained in this position until 31 August 1934, working primarily with his professor Ludwig Berwald.

During that period Löwig dedicated himself intensely to mathematics, preparing his works for publication and also lecturing at the *Mathematisches Kränzchen in Prag* [Mathematics Circle in Prague] and at the *Deutsche physikalisch-mathematische Gesellschaft in Prag* [German Physics and Mathematics Society in Prague].

In the spring of 1934, Löwig assumedly requested an extension of his *Graduate Teaching Assistant* appointment. In relation to this, a detailed investigation was carried out by the police to ascertain his political leanings and any activity in dissolved and banned German nationalist parties. Even though the detailed investigation found Löwig had never been politically active, his university appointment as *Graduate Teaching Assistant* was not extended.

Throughout his time as Graduate Teaching Assistant, Löwig was intensely preoccupied with the solvability of linear and non-linear difference and differential equations with special coefficients (assumedly under the influence of L. Berwald and G. A. Pick). In 1931, Löwig published two extensive works in the renowned international journal Acta Mathematica entitled *Lineare Differenzengleichungen mit Koeffizienten von gemeinsamer Periode* [Linear difference equations with periodic coefficients] [L2] and *Zur Theorie der nicht linearen Differenzengleichungen* [On the theory of nonlinear difference equations] [L3]. These were in the way of mathematical monographs and their content was praised in a review by the German mathematician Oscar Perron. In the article titled *Lösung der Aufgabe 97 von Anton E. Mayer aus dem Jahresberichte der D. M. V.* [Solution to task 97 set by Anton E. Mayer in the D. M. V. Annual Report, 1933] [L4] he published an interesting and elegant solution to geometry problem No. 97 that was posed in the journal Jahresbericht der Deutschen Mathematiker-Vereinigung (40(1931), 46). In the no less renowned journal Mathematische Annalen, he published a detailed analysis of the characteristics of first order partial differential equations, called *Bemerkung zu einem Satze von A. Kneser über die Charakteristiken einer partiellen Differentialgleichung erster Ordnung* [Comment on a theorem of A. Kneser on the characteristics of first order partial differential equations, 1933] [L5], which was praised by A. Hammerstein of Kiel.

On 1 August 1934 Löwig was appointed *Aspirant der Professur* [interim mathematics and physics teacher] at the *Deutschen Staatsrealgymnasium in Leitmeritz* [German State Grammar School in Litoměřice]. He worked there until 31 September, 1935, teaching mathematics and natural sciences for 18 hours per week in junior classes. In this period he also became a member of the professional associations *Lotos* and *Deutsche Mathematiker-Vereinigung* [German Mathematical Society].

Heinrich Löwig's later pre-war career

On 27 February 1934 Heinrich Löwig made an application to the Faculty of Science at the German University in Prague for habilitation (qualification for teaching at universities). As a habilitation thesis, he presented his groundbreaking study *Komplexe euklidische Räume von beliebiger endlicher oder transfiniter Dimensionszahl* [Complex euclidean spaces of any finite or transfinite dimension] [L6], which discussed the dimensions of vector spaces in finite and infinite dimensions and applications of this theory to functional analysis and had been published in the journal Acta Litterarum ac Scientiarum Regiae Universitatis Hungaricae Francisco-Josephinae, Sectio Scientiarum Mathematicarum,

Szeged in 1934. He supported his latest professional interest with his short work *Über die Dimension linearer Räume* [On the dimension of linear spaces] [L7], published in the journal Studia Mathematica. It is very likely that Löwig's choice of topics in the mid 1930s was greatly influenced by Karl Löwner and Paul Funk, young professors at the German University in Prague who kept up with world trends in mathematics. In 1935, after a short habilitation process (professors' reviews, committee recommendation, habilitation lecture titled *Über das aktual Unendliche* [About actual infinity]) Löwig was granted Venia Docendi qualifying him as *Privatdozent* [Adjunct Professor] of mathematics and bestowing on him the right to teach mathematics at the German University in Prague.

Heinrich Löwig's university work from 1935 to 1937

After successful habilitation, Heinrich Löwig began lecturing in mathematics at the Faculty of Science of the German University in Prague. In the winter semester of the 1935/36 academic year, he taught an optional five hour per week course called *Differentialgeometrie (Theorie der Raumkurven und Flächen)* [Differential geometry (Theory of space curves and surfaces)]. In the summer semester of that year he led an optional three hour per week course called *Unendlichen Reihen (mit Übungen)* [Infinite series (with exercises)]. In the winter semester of 1936/37 he was entrusted with giving a manadatory two hour per week course called *Infinitesimalrechnung für Hörer der Chemie* [Calculus for chemistry students]. He gave no university lectures in the following three semesters (summer 1936/37, winter 1937/38, summer 1937/38).

It is of note that on 23–28 September 1934, Löwig attended the Second Mathematical Congress of Slavic Countries held in Prague. There on 27 September he gave a lecture in the mathematical analysis segment called *Über allgemeine Spektralfunktionen* [On the fundamentals of spectral functions] [L8], the content of which was later published in the journal Časopis pro pěstování matematiky a fysiky [Journal for the Cultivation of Mathematics and Physics].

Heinrich Löwig's teaching career from 1935 to 1938

On 1 September 1935 Heinrich Löwig was appointed *Interim Mathematics and Physics Teacher* at the *Deutsche Staatsrealgymnasium in Reichenberg* [German State Grammar School in Liberec], where he taught until 31 August 1936. From 1 September 1936 he was transferred to the *Städtisch Mädchenreformrealgymnasium in Reichenberg* [German Girls Modern Grammar School in Liberec], where he taught as *Interim Mathematics Teacher* until 31 January 1937. From 1 February to 31 August 1937 he was interim teacher at the German State Grammar School at Ústí nad Labem. From 1 September 1937 to 31 August 1938 he was *Mathematics Teacher*, still temporary, at the German State Grammar School at Frývaldov (today Jeseník).

In 1937, in the journal Mitteilungen aus dem höheren Schulwesen, Heinrich Löwig published an article on the basis of his teaching experience called

Die Einführung der Differentialquotienten im Mittelschulunterrichte. „Wissen und Wirken" [The introduction of differential quotients in high school lessons. "Knowledge and action"] [L9], which dealt with didactic methodology.

On 1 September 1938 Löwig at last attained a permanent appointment as mathematics and physics teacher at the German State Grammar School in Nový Jičín. However, before he could take up the position, the mobilisation began and Löwig had to enlist.

On 30 September 1938, as a result of the Munich Pact, the Czechoslovak Republic was obliged to hand over a large part of its territory to Germany, Poland and Hungary. The remaining truncated area was declared the Second Czechoslovak Republic. Nový Jičín was within the so-called occupied territory, which is why on 1 October 1938 Löwig had to give up his teaching position and leave the Sudetenland.

In the October, Löwig moved to Prague. Because he was unemployed, he turned to the Faculty of Science at the German University to exercise his right as Venia Docendi. At the beginning of the 1938/39 winter semester he was intended to teach an optional two-hour per week lecture course *Mengenanalysis (Voraussetzung: Differential- und Integralrechnung)* [Set theory (Prerequisite: differential and integral calculus)].

To provide an overall context – in the 1938/39 winter semester at the Faculty of Science of the German University in Prague there were three full professors of mathematics (Ludwig Berwald, Karl Löwner and Paul Funk), an extraordinary professor of mathematics (Arthur Winternitz), four qualified docents of mathematics (Heinrich Löwig, Ernst Lammel, Maxmilian Pinl and Otto Warga), Dr Walter Fröhlich, professor of astronomy Erwin Finlay-Freudlich and professor of geophysics and astronomy Leo Wenzel Pollak. Together they offered 20 mandatory and optional courses. Physics lectures were given by two full professors (Reinhold Fürth and Phillipp Frank) and three docents (Otto Blüh, Walter Glaser and Kurt Sitte).

The situation however worsened during the autumn of 1938 and spring 1939, as fascist and anti-Jewish tendencies grew in the university community. As a result of racist regulations, by the 1938/39 summer semester the only docents remaining at the mathematics department were Otto Warga and Ernst Lammel. Another docent, Alfred Rössler, was called from the German Technical University to help out with teaching geometry. They were able to offer only three mandatory courses for students of mathematics, plus one seminar and one proseminar. At "pure" physics, only one docent remained – Walter Glaser. And so the pure sciences at the Faculty of Science of the German University in Prague were nearly destroyed.

The wartime story of Heinrich Löwig's father

As was alluded to earlier, after retiring in 1930 Löwig's father Heinrich Löwig moved with his wife Katharina to Liberec where he intended to spend his

retirement. In August 1938, Heinrich Löwig refused to leave German occupied territory, leading to his arrest by the Gestapo. Then Heinrich Löwig followed his son to Prague and he applied for and was granted Czechoslovak citizenship and received his regular pension. On 30 December 1939 he obtained a new identity card. His situation quickly worsened from 15 March 1939 with the establishment of the Protectorate of Bohemia and Moravia. Very soon after occupying the region, the Germans put in place radical racial laws, resulting in Heinrich Löwig's name being listed on the register of Prague's Jewish residents.

During the war, he changed addresses several times, sometimes living alone and sometimes with his wife and son. According to his son's account, his father was arrested by the Gestapo on 21 August 1944 and taken without appeal to the Small Fortress (the infamous Gestapo prison) in Theresienstadt, where on 31 August 1944 he died after interrogation.

Jindřich Löwig's wartime story

After arriving in Prague in the autumn of 1938, the younger Heinrich Löwig subscribed to Czechoslovak nationality. On 22 April 1939 he applied for Czechoslovak citizenship and became a citizen of the Protectorate. From that time he called himself Jindřich Löwig (Czech for Henry).

During the winter of 1938 it became apparent that his situation was almost hopeless, as Jindřich Löwig could not attain any position equal to his qualifications. Because of his father's origins, under the racial laws Jindřich Löwig was identified as a first degree half-caste and listed on the register *First degree half-castes of working age in Prague*. The Protectorate's 4 June 1939 ruling hit him hard, with his employment terminated and no pension approved. In the years 1940 to 1943, he could obtain no employment of a professional nature. In May 1943 he was forced by the Office of Employment to take a job as assistant labourer at the firm Remeš & Co. (Kollár's Square in Prague), a firm that manufactured metal goods.

Throughout that time, while fearing the possibility of transport to a Jewish ghetto, labour camp or concentration camp, Löwig studied mathematics, specifically abstract algebra. He read journal articles by B. L. van der Waerden (1903–1996), J. von Neumann (1903–1957) and B. A. Bernstein, studied articles in the journals Mathematische Annalen, Annals of Mathematics and Bulletin of the American Mathematical Society, and studied modern algebra textbooks and monographs written by B. L. van der Waerden, C. C. MacDuffee (1895–1961), G. Birkhoff (1911–1996) and S. MacLane (1909–2005). During this time Löwig also kept in touch with Czech, German, Austrian, Hungarian and American mathematicians and he studied mathematics.

During the war years, Löwig succeeded in publishing two works in the American journal Annals of Mathematics entitled *Intrinsic topology and completion of Boolean rings* [L10] and *On the importance of the relation* $[(A, B), (A, C)] = (A, [(B, C), (C, A), (A, B)])$ *between three elements of a structure* [L11], which

focused on modern topology and Boolean environments. G. Birkhoff endorsed the quality of his work in the journal Mathematical Reviews.

Until 15 October 1944, Löwig lived with his mother in Prague and worked as an unskilled labourer's assistant at the metal works. On 16 October 1944 he was transported to a German labour camp at Klettendorf at Breslau (Vratislav, Wrocław) and was later transfered to camps at Gräditz, Tvoršovice and Bystřice u Benešova.

Katharina Löwig's wartime story

Jindřich Löwig's mother Katharina Löwig did not have an easy time either during the war. As German Catholics, she and her husband applied for recognition as Czech nationals in the autumn of 1938. She began to call herself Kateřina Löwig. After the proclamation of anti-Jewish laws, she refused to divorce her husband and hoped that this would save him and her son from being transported to ghettos and camps. This however put her into a difficult position, which she faced bravely. During the war she variously lived with her husband and her son. To save her Jewish husband from being transported to Terezín (Theresienstadt Ghetto), she applied for German citizenship in 1941, which would automatically place her under German jurisdiction. On 5 December 1942 she was given a German identification card and her name was recorded in the Prague register of German residents. In the autumn of 1943 the Prague Gestapo began investigating her right to citizenship under the fascist regime. On 17 June 1944 German officialdom revoked her German citizenship and from that moment Kateřina Löwig had to report again as a Czech citizen and register under Protectorate jurisdiction. When the war ended, in May 1945 she was arrested as a German and imprisoned at the Convent in Břevnov. On the basis of an intervention by her son Jindřich Löwig, she was released.

Anna Löwig's story

On 11 September 1926 in Liberec, Anna Löwig married Rudolf Epstein (1898–1977), originally of Turnov. On 2 August 1928 she left the Catholic Church and proclaimed her Jewish faith. They had three children Peter (1928–2004), John (born 1930) and Margit (born 1935). In September 1938, Epstein family emigrated to England and after the war they lived happily and contentedly in London. Their children started their own families and prosperous business ventures.

Jindřich Löwig's life from 1945 to 1947

At the beginning of May 1945, Jindřich Löwig returned to Prague from the German labour camps and contacted Vladimír Kořínek (1899–1981), a Czech mathematician, to ask for help with finding a job in line with his qualifications.

As is known, after the war the Beneš Decrees were proclaimed, which regulated the status of citizens of German and Hungarian nationality, collaborators and advisors. The fact that the Löwig family had opted for German nationality

in the 1930 census was not in their favour. Jindřich Löwig, tutor, and Kateřina Löwig, retiree without assets, had to prove their national reliability.

Kořínek tried to help Löwig and he vowed that he would support a simple transfer for the purpose of renewing Jindřich Löwig's habilitation procedures, but he stressed it was necessary to sort out any citizenship issues. From correspondence with Vladimír Kořínek and Eduard Čech (1893–1960), an internationally renowned Czech mathematician, it seems that Löwig obtained Czechoslovak citizenship at the end of June 1947.

Kateřina Löwig's life from 1945 to 1947

Between 1945 and 1947 Kateřina Löwig was in an unenviable position. Because of perceived German nationality, she was repeatedly investigated under the so-called „Small Decree". In 1945 she had to complete a form to determine German citizenship, but she succeeded in proving that her husband was tortured by the Gestapo, her German citizenship was revoked by the fascist regime, she never showed any sympathy for the fascist regime, she was not politically active and was not a member of fascist parties, she never denounced her country of birth, none of her property was inherited from traitors and collaborators, she was receiving a small pension because of her husband, and there were no complaints about her from her Czech neighbours.

In 1947 Jindřich Löwig and his mother Kateřina Löwig did indeed succeed in obtaining Czech citizenship, but only as "second class citizens"; they were still considered suspicious German persons and had difficulty obtaining identity cards, travel documents and employment.

Jindřich Löwig's Emigration

According to Jindřich Löwig correspondence with Vladimír Kořínek and Kořínek's correspondence with Eduard Čech, in 1947 Jindřich Löwig tried to obtain positions at the Faculty of Science of Charles University and at the newly established Faculty of Education at the Palacký University in Olomouc. Kořínek willingly assisted Löwig, as is evident from their correspondence during 1947. Kořínek also tried to help him gain approval for travel to the University of Greifswald, where he had been offered a good position as extraordinary professor of mathematics, and he supported his application for a university position in Australia. However in the end things turned out differently because Löwig was given permission to visit his sister Anna Epstein in London. Vladimír Kořínek followed up what was happening with Löwig's request to obtain teaching position at the Palacký University in Olomouc and let him know via a letter to London that his request was absolutely impossible according to Ministry of Interior information that proclaimed it unacceptable to employ German nationals in public service.

In spite of this Jindřich Löwig did not stay in London as might have been expected, but returned to Czechoslovakia. He applied for an emigration visa and intended to sort out matters without losing his citizenship and the ability

to return to Prague where his mother was still living. He accepted the offer of a mathematics lecturing position at the University of Tasmania in Hobart, Australia and on 8 January 1948 departed for Australia. He simply obtained a passport valid to 31 December 1949. He was meant to return to Czechoslovakia by that date at the latest or else renew his passport, obtain an emigration pass, or otherwise regularise things with his native country.

Katharina Löwig's emigration to England

On 30 October 1948 Kateřina Löwig applied for a passport, so she could move to England to live with her relatives. She had to present a range of documents required by the procedure and at the end of 1948, Kateřina, from then once again calling herself Katharina Lowig, moved to London where she lived with her daughter Anna Epstein and her family until her death in 1962. Towards the end of her life she had difficulty breathing and tolerated poorly the then polluted London smog.

Henry Lowig's career in Australia 1948 to 1957

And so in 1948 in Australia at age 43, Jindřich Löwig began for a third time to build a new life and career, almost out of nothing. From then on he began to call himself Henry Lowig, and hence is referred to as Henry Lowig from this point in this chapter. He became *Lecturer in mathematics* and in 1951 *Senior Lecturer* at the University of Tasmania in Hobart. We note that he had perfect command of Latin, Greek, German and Czech and that during the war had taught himself English and later in Canada also taught himself French. From 1948 in Hobart he lectured in English. On 5 May 1951 he gained the degree of Doctor of Science (D.Sc.) in mathematics at the University of Tasmania.

Henry Lowig maintained quite regular written contact with Vladimír Kořínek, sending him articles for publication in Czech journals along with relevant peer reviews and off-prints of his publications in German and English journals. He continued having a lively interest in developments in Czechoslovakia and the work of Czech mathematicians.

From 1951 to 1957, Lowig focused on topics to do with abstract algebraic structures (algebras and sets); he studied characteristics of operations and improved, sharpened and filled in the definitions of basic objects and proofs of known results. He published in German or English articles entitled *On transitive Boolean relations* [L12], *Bemerkung zu den Primquotienten eines distributiven Verbandes* [Comments on the prime quotients of distributive lattices] [L13], *On the properties of freely generated algebras* [L14], *Gesetzrelationen über frei erzeugten Algebren* [Law relations and freely generated algebras] [L15] and a briefer English version *On the existence of freely generated algebras* [L16], which were reviewed in the journals Jahrbuch über die Fortschritte der Mathematik and Zentralblatt für Mathematik und ihre Grenzgebiete.

Henry Lowig's family

On 7 September 1949 in Hobart, Henry Lowig married Libuše Barbora Ottová (born 21 July 1925) of Smíchov, Prague, daughter of František Otta and Žofie born Myslivcová. On 26 August 1953 he became an Australian citizen without losing his Czechoslovak citizenship. In 1954 he applied for and was granted an official name change from Heinrich Franz Josef Löwig to Henry Francis Joseph Lowig, as he did not wish to be perceived as German. From then to the end of his life he called himself Henry Francis Joseph Lowig. The couple had two children, a daughter Ingrid Henriette (born 1952) and a son Evan Henry Francis (born 1954). At home the family always spoke in Czech and his wife called Henry by his Czech name. In Hobart the couple first lived in a rented flat. In 1950 they rented an apartment in a house near the beach at Sandy Bay. From 1951 to 1954 they rented another apartment near central Hobart. In 1955 they bought a newly built house in the Hobart suburb Taroona where they lived until 1957.

Henry Lowig and the Czechoslovak Republic

On 20 September 1950, the Second Section of the District National Security Headquarters in Prague V filed a criminal complaint against H. Lowig for living illegally outside the Czechoslovak Republic. He was accused of living illegally overseas and having a hostile attitute towards the People's Democratic Government. On 18 October 1950 the prosecution was interrupted in order to carry out further investigations. On 7 November 1950 the financial prosecutors in Prague were asked to investigate Lowig's assets in Czechoslovakia. On 25 March 1952, on the basis of the financial report, it was documented on file that the investigated had mobile assets in Czechoslovakia valued at 129,970 Crowns and no immobile assets. Lowig was never able to obtain access to his money.

Henry Lowig's career in Canada 1957 to 1995

In 1956 Henry Lowig became aware of a position advertised at the Mathematics Department of the University of Alberta in Edmonton, Alberta, Canada. On 22 May 1957 the Executive Committee of the Board of Governors of the University of Alberta approved Lowig's appointment as *Associate Professor* for a two year probationary period. Lowig accepted the position to lecture in mathematics and algebra. In September 1957 the Lowig family left Hobart and moved to Edmonton. Initially for about a year, they lived in a rented house in Edmonton. In 1958 they bought a house in the suburb of Avonmore. In 1962 they bought a new modern house with charming garden in Lynnwood, where Libuše Lowig remained until 2002.

In the summer of 1958, Lowig visited London with his whole family, and they stayed at his sister's Anna Epstein's home. There, for the first time in 10 years, he was again reunited with his mother. It was also to be the last time.

On 5 June 1959 the Board of Governors appointed Lowig as a tenured *Associate Professor*. During the 1966/67 academic year Lowig took sabbatical leave from the university in Edmonton and spent a year as *Visiting Research Fellow* at the Department of Mathematics of the Institute of Advanced Studies at the Australian National University in Canberra, Australia. The whole family spent the year in Canberra and lived in university accommodation – a two storey townhouse in Carroll Street, Hughes. While he was in Australia he was notified of his appointment as *Full Professor in Mathematics* at the University of Alberta from 1 June 1967. He continued in this position through to the academic year 1969/70. On 31 August 1970 he retired and was awarded the title *Professor Emeritus*. During the academic year 1970/71 he worked as *Sessional Lecturer* and in 1971/72 he lectured as *Professional Associate*. He finally fully retired on 1 October 1972. He continued have to an office at the university which he was able to use for the rest of his life.

Henry Lowig lived happily surrounded by his family in the peaceful Canadian atmosphere, quite apart from world's political, social and economic woes. He rejoiced in the successes of his children and travelled a lot with his wife and children, but never returned to Czechoslovakia. On 16 June 1964 he became a Canadian citizen, thereby forfeiting his Australian citizenship.

Throughout that time Henry Lowig kept in touch with Vladimír Kořínek in letters written in excellent Czech. He maintained an interest in Czech mathematics journals, the activities of the Union of Czechoslovak Mathematicians and Physicists, and read the works of his Czech colleagues. When he encountered Czech mathematicians who emigrated to Canada, he was interested in their welfare and tried to help them out. He did not hesitate, however, to impede any attempts to defraud Canadian universities with fake diplomas or falsified translations supposedly from the Charles University in Prague. Evidence of his interest in Czechoslovak culture was his lifelong membership of the *Czechoslovak Society of Arts and Sciences*, which comprises scholars, scientists, artists, writes, students, lawyers, businessmen, and others throughout the world who have a professional, family or other interest in the Czech Republic and Slovakia.

During his active work life in Alberta, Henry Lowig published four articles dedicated to the study of special properties of lattice relations and absolutely free algebras: *On some representations of lattices of law relations* [L17], *On the composition of some representations of lattices of law relations* [L18], *Note on the self-duality of the unrestricted distributive law in complete lattices* [L19] and *On the definition of an absolutely free algebra* [L20].

Henry Lowig's retirement and last years

Henry Lowig finally retired from lecturing in 1972, but he continued going to the Mathematics Department at the University of Alberta. He continued being interested in the results of modern algebra and he published shorter works on theoretical algebra. In the 1970's he published articles named *On algebras generatable by a given set of algebras* [L21], *Note on the theory of independence*

in continuous geometries [L22], *Vollständige Mengen von Algebren* [Complete sets of algebras] [L23] and *On the completion of relatively complemented distributive lattices* [L24]. His results in the area of set theory are cited even today (see Mathematical Reviews and Zentralblatt für Mathematik und ihre Grenzgebiete). He wrote insightful reviews for the journal Mathematical Reviews until 1994.

Henry Lowig died on 1 July 1995 in Edmonton.

Scientific works

Löwig's works on functional equations (A. Slavík)

The defense of Heinrich Löwig's doctoral thesis *Über periodische Differenzengleichungen* took place at the German university in Prague, December 1927. The thesis itself is no longer extant, but its contents were summarized in a short four-page outline [L1]. More importantly, the results were published in a series of two extensive papers [L2] and [L3], which appeared in Acta Mathematica in 1931. According to Löwig, the two papers represent a revised and extended version of his original thesis. Although the titles refer to "difference equations", the term "functional equations" seems more appropriate from today's viewpoint.

The topic was inspired by earlier investigations of Émile Picard published in Acta Mathematica under the title *Sur une classe des transcendantes nouvelles*. The object of Picard's study was a system of functional equations

$$f_k(z+h) = Q_k(f_1(z), \dots, f_n(z)), \quad k \in \{1, \dots, n\},$$

where $Q_1, \dots, Q_n$ are known and $f_1, \dots, f_n$ unknown functions, z is a complex variable, and h is a nonzero complex number. Under certain assumptions, Picard was able to show the existence of ω-periodic solutions of the given system of equations for every nonzero $\omega \in \mathbb{C}$ which is not a real multiple of h. This result might be interpreted as a generalization of elliptic functions, i.e. functions with two linearly independent complex periods h and ω.

Löwig has succeeded in generalizing Picard's results to systems of the form

$$f_k(z+h) = Q_k(z, f_1(z), \dots, f_n(z)), \quad k \in \{1, \dots, n\}, \tag{1}$$

where the right-hand sides now depend not only on $f_1, \dots, f_n$, but also on the variable z. The paper [L2] is devoted to linear functional equations, which represent an important special case of the system (1); the results obtained here were subsequently used in [L3] to analyze the general nonlinear system (1).

Löwig's works in functional analysis (J. Bečvář)

In his habilitation thesis *Komplexe euklidische Räume von beliebiger endlicher oder transfiniter Dimensionszahl* [L6] from 1934, H. Löwig followed earlier investigations by F. Hausdorff, S. Banach, J. von Neumann, E. Schmidt, S. Mazur, D. Hilbert, and F. Riesz. He explained the basic notions and theorems of

the theory of complex normed linear spaces, and stated numerous results in Hilbert space theory. The core of his work is divided in two parts, depending on whether or not he made use of Zermelo's well-ordering theorem.

He showed that the assumption of separability, which was a common part of the definition of a Hilbert space at the time, is not really substantial. He was the first to describe the structure of a functional on the complex space by the relation

$$L\mathfrak{r} = R\mathfrak{r} - iR(i\mathfrak{r}).$$

His work was closely related to certain essential results of functional analysis, which were discovered in the previous three decades and had their origin in the works of F. Riesz, E. Fischer, and M. Fréchet from the beginning of the century. These results were concerned with the isometry between the spaces L_2 and l_2, its construction based on maximal orthonormal sets, completeness of these spaces, the general form of a continuous (bounded) linear functional on L_2 and l_2 etc.

Löwig's work [L6] received a wide response. It was referenced by numerous authors and cited in several textbooks and monographs (N. I. Achiezer and I. M. Glazman, F. Riesz and B. Szökefalvi-Nagy, G. Köthe, N. Bourbaki, N. Dunford and J. T. Schwartz, V. I. Istratescu, E. Kreyszig, F. Deutsch, V. Komornik, B. D. MacCluer, A. Pietsch).

The subsequent work *Über die Dimension linearer Räume* [L7] from 1934 is directly inspired by the research initiated by F. Hausdorff and S. Banach in 1932.

Löwig considered both real and complex normed linear spaces and introduced two different notions of a dimension – the *affine dimension* coincides with the classical dimension of a linear space, while the *metric dimension* is the smallest cardinal number among the cardinalities of all sets whose closed linear span is the whole space. He noted that the affine dimension is never smaller than the metric dimension.

He recalled the already usual notion of a *basis* (a linearly independent spanning set), which corresponds to the affine dimension. He proved that every space (with an infinite spanning set) has a basis (Zorn's lemma was not available at the time), that all bases have the same cardinality, and showed the relation between the cardinality of a linear space and its affine dimension (he needed some basic facts about infinite cardinal numbers here).

As a next step, he introduced the notion of a *fundamental set*, which corresponds to the metric dimension, and compared it with other similar notions used by Hausdorff and Banach. He also noted that in a complete Euclidean space, a maximal orthonormal set is necessarily a fundamental set.

Even this work was met with a great response and was cited in textbooks and monographs (P. R. Halmos, A. E. Taylor, M. M. Day, B. V. Limaye, H. Schröder, A. Pietsch, R.-H. Schulz).

A short article *Über allgemeine Spektralfunktionen* [L8] presents the main result of Löwig's communication from the second meeting of Slavic countries mathematicians, which took place in Prague in 1934.

Löwig's works in algebra (J. Bečvář, V. Dlab)

Since the beginning of 1940s, Löwig turned his attention to lattice theory, Boolean rings and algebras (the works [L10] to [L24] and preliminary communications [L25] to [L27]). He followed especially the works of G. Birkhoff, Ø. Ore, M. H. Stone, and J. von Neumann. He generalized results from the theory of Boolean σ-rings, and contributed to the evolution of ideas concerning modular and distributive lattices and freely generated algebras. His results were later elaborated by a number of authors, especially J. Schmidt, K.-H. Diener, and R. Kerkhoff. Löwig's works are cited in the monographs by G. Birkhoff, G. Grätzer, and R. Sikorski.

The long paper entitled *Intrinsic topology and completion of Boolean rings* [L10] is concerned with the completion of a Boolean ring into a σ-complete Boolean ring in which the original ring is densely contained.

In a short treatise *On transitive Boolean relations* [L12], Löwig presented necessary and sufficient conditions guaranteeing that the relation R defined by

$$xRy \overset{\text{def}}{=} axy + bx\bar{y} + c\bar{x}y + d\bar{x}\bar{y} = 0$$

is a transitive relation, equivalence relation, quasi-ordering, or partial ordering determining a Boolean algebra.

Several works of Löwig are devoted to modular and distributive lattices.

In a paper entitled *On the importance of the relation $[(A, B), (A, C)] = (A, [(B, C), (C, A), (A, B)])$ between three elements of a structure* [L11], he constructed the non-modular lattice L_9 consisting of nine elements,
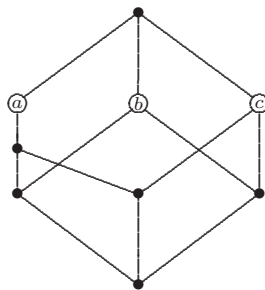
in which the elements a, b, c do not satisfy

$$(a \wedge b) \vee (a \wedge c) = a \wedge [(a \wedge b) \vee (a \wedge c) \vee (b \wedge c)],$$

but satisfy the dual inequality

$$(a \vee b) \wedge (a \vee c) = a \vee [(a \vee b) \wedge (a \vee c) \wedge (b \vee c)].$$

In modular lattices, both of these equalities are satisfied.

Löwig showed that *every lattice which does not satisfy the first equality contains a sublattice isomorphic to L_9.*

At the same time, his argument explains why every lattice with at most eight elements satisfies the first identity.

Other works of Löwig, [L13], [L19], and [L24], are concerned with distributive lattices. For example, in the paper *On the completion of relatively complemented distributive lattices* [L24], Löwig extended the embedding of a relatively complemented distributive lattice with a null element into a complete Boolean algebra to the case of a relatively complemented lattice without a null element.

The work *Note on the theory of independence in continuous geometries* [L22] was motivated by a result from von Neumann's *Lectures on Continuous Geometry* published in 1937, namely the characterization of the notion of *independence* in a complete complemented modular lattice.

In the treatise *On the properties of freely generated algebras* [L14], Löwig made precise the notion of Birkhoff's *freely generated algebra* in the case when there is no restriction on neither the number of operations nor their *arity*. This work was followed by a series of subsequent papers – [L15] to [L18], [L20], [L21], and [L23].