Walter Ledermann passed away peacefully on 22 May 2009 in London less than two years short of his 100th birthday. He was born into a Jewish family in Berlin on 18 March 1911, the second of four children. His father, William Ledermann, was a medical doctor and his mother, Charlotte née Apt, was the daughter of a wealthy metal merchant. He entered the Köllnisches Gymnasium in Berlin in 1917, progressing to the Leibniz Gymnasium in the same city in 1920. There he learnt classics, studying Latin for nine years and Greek for six years. The school also taught French but, as was usual at this time, not much science. Although very little mathematics was taught in German schools in general at this time, Walter had the advantage that the Leibniz Gymnasium taught more mathematics than other schools as a mark of respect for Gottfried von Leibniz after whom the school was named. He enjoyed studying the classics, especially Greek with its wonderful literature, but became fascinated by mathematics from his first lesson at the age of eleven. From that time on he decided to make mathematics his career. Also from age 11 he began learning to play the violin, the cost of a lesson in these times of hyperinflation being set at the cost of a loaf of white bread. Music played a large role in Ledermann's life from that time on.

In 1928, when he was seventeen years old, Ledermann graduated from the Leibniz Gymnasium and entered the University of Berlin to study for the Staatsexamen, the qualification necessary to enter secondary school teaching. At the University of Berlin, Ledermann was taught by many famous mathematicians and physicists including Issai Schur, Erhard Schmidt, Richard von Mises, Max Planck, Erwin Schrödinger, Heinz Hopf, Georg Feigl, and others. As one might imagine, given this array of famous names, he found it a stimulating experience but the teacher who inspired him most was Schur. Ledermann's main subjects were mathematics and physics, but he also had to study chemistry to a lower level and to take an oral examination on philosophy. During his university studies Ledermann spent one semester in Marburg in 1931 but, other than this, all his courses were taken in Berlin.

Ledermann was nearing the end of his studies for the Staatsexamen when Hitler came to power in 1933 and the German government began passing anti-Jewish legislation. In order to complete the course he had to write a dissertation and be given an oral examination. Schur gave him the topic for his dissertation *On the various ways of expressing an orthogonal matrix in terms of parameters* and although Schur, being a Jew, was forbidden from teaching at the University, he was allowed to conduct the oral examination in November 1933. A second examiner at the oral was Ludwig Bieberbach who was wearing Nazi uniform.

It was quite clear to Ledermann that he had to leave Germany to escape the Nazi persecution of the Jews. He had already made strenuous efforts to find a way to leave Germany before his oral, but then his elder brother Erich, who was studying medicine in Edinburgh, told him about a scholarship from the International Student Service in Geneva to study at the University of St Andrews. He won the scholarship, funded by the students and citizens of St Andrews, and was supplied with the necessary papers to allow him to travel to Scotland in January 1934.

At first it appeared that he might get caught up in the University of St Andrews' regulations. The problem was that the Staatsexamen was awarded by the Ministry of Education, not by the University of Berlin, making it a diploma rather than a degree. Fortunately Ledermann was spared the stupidity of having to take the undergraduate courses at St Andrews and, for the first time in the five hundred years history of the University, a person with a German state qualification was admitted as a research student. His doctoral studies were supervised by Herbert Turnbull and he was awarded his PhD in 1936. Ledermann had studied the problem of finding the canonical form for a pair of real or complex $n \times n$ matrices under simultaneous equivalence. He had also worked on the problem of classifying the stabiliser of the pencil which is a linear combination of the two matrices.

Following his doctorate, Turnbull advised him to speak to Edmund Whittaker in Edinburgh about the possibility of a position there. Whittaker arranged a small bursary for Ledermann and suggested that he attend Alec Aitken's lectures. The most fruitful work Ledermann undertook during this period was as a private assistant to Professor Sir Godfrey Thomson at the University of Edinburgh. Thomson headed the Moray House Group in Edinburgh which was undertaking research into intelligence
testing, and Ledermann was able to use his expert knowledge of matrix theory to put the work of this group onto a sound mathematical footing. As well as matrix theory, he was involved in using statistical methods and he retained this interest in his later research publications. The quality of the work Ledermann undertook at this time is clearly shown from the fact that Edinburgh awarded him a DSc for it in 1940. While in Edinburgh, Ledermann also worked with Max Born. He was able to use his mathematical skill in matrix theory to resolve a dispute in Born's favour between Born and the physicists C. V. Raman and N. S. Nagendra Nath. The dispute concerned the foundations of lattice dynamics, in particular, the thermal theory of X-ray scattering. This result is contained in his 1943 paper *Density of frequencies in lattice dynamics* written with Max Born.

Ledermann took a six month break from his work in Edinburgh in 1937 when appointed as a temporary lecturer at the Mathematics Department in Dundee, and in 1938 he returned to St Andrews where he remained until 1946. During this time he became a British citizen (1940) and also undertook some war work. Soon after beginning his teaching career in St Andrews he was struck by the lack of good-quality, cheap, pocket-sized mathematics textbooks which had been common in Germany. His suggestion to Dan Rutherford for a series of such texts was taken up, and the Oliver & Boyd series of mathematical texts was born. Despite being the one to come up with the idea, Ledermann could not become an editor since it was felt impossible at that time to have a German take such a role.

While in St Andrews, he formed a close friendship with Finlay Freundlich, head of the St Andrews Observatory, who introduced him to Ruth Stefanie (Rushi) Stadler, whom he married in 1946. Rushi was a Jungian psychoanalyst who shared Walter's love of music, and the newly married couple decided to move to a bigger city so that she might be able to pursue her career. Ledermann accepted a lectureship at the University of Manchester in 1946 and spent sixteen stimulating and fruitful years in Manchester. Particularly of note is the fact that he was secretary to the first British Mathematical Colloquium which he organised in Manchester in September 1949, at the request of William Hodge, Henry Whitehead and Max Newman. In organising this conference, he relied heavily on his experience of helping to run the Edinburgh Mathematical Society Colloquium held in St Andrews in the summer of 1934. At Manchester, Ledermann repeated the success of his suggested Oliver & Boyd Series with the Routledge & Kegan Paul student series *Library of Mathematics* which was again a series of small cheap texts, but primarily aimed at students for whom mathematics was a subsidiary subject. Sensitivity over German names was no longer an issue, so Ledermann became the editor for the series which ran to around twenty volumes.

In Manchester he collaborated with a number of colleagues, writing two papers with Harry Reuter on Markov processes, one with John Cassels and Kurt Mahler on the geometry of numbers, two with Bernard Neumann on the automorphism group of a finite group, and six with Peter Hilton on homological ringoids and homological monoids. He was promoted to Senior lecturer in 1953 and the Ledermann’s son Jonathan was born in 1954. By 1960 Rushi was making frequent trips to London as part of her work as a psychoanalyst. Deciding that it would be better for the family to live in or near London, Ledermann began applying for Chairs at London Colleges; he was not successful but the newly established University of Sussex presented an interesting opportunity. In 1962 he accepted a readership at Sussex and, three years later, he was promoted to Professor. He retired in 1978 and was made Emeritus Professor.

As indicated earlier, Ledermann published on Markov processes, homology theory, group theory, and number theory but, despite the different areas in which he worked, there are common threads. As a result of Schur's teaching he developed a liking for "concrete" mathematics and a distaste for "abstraction" for its own sake. This is evident, even in his work in what is usually thought of as one of the most abstract of topics, homology theory. Ledermann's book *Introduction to the Theory of Finite Groups* (1949) became a classic. The topics covered in the book look fairly standard today, but one has to remember that in the 1940s there were few group theory texts, and the concept of standard material for such courses did not exist. The little book (152 pages) discusses the group axioms, isomorphisms, cyclic groups, coset decompositions, Lagrange's theorem, permutation groups, normal subgroups, quotient groups, homomorphisms, the first and second isomorphism theorems, and the Jordan-Hölder theorem. The simplicity of the alternating groups is proved and the Sylow theorems, $p$-groups and finitely generated abelian groups are discussed. Ledermann succeeds admirably in
meeting his own aims in that he "never hesitated to sacrifice completeness for breadth or to reject more modern methods when [he] considered alternative presentations to be more intelligible."

Other books which Ledermann has written for undergraduates include *Complex numbers* (1960), *Integral calculus* (1964), *Multiple integrals* (1966), *Introduction to group theory* (1973), and *Introduction to group characters* (1977). This last volume, which still shows Schur's influence, strikes a good balance between the abstract approach to representation theory emphasising modules, and the concrete approach built around matrices. It is an outstanding text from which to teach the topic. Among the editorial work undertaken by Ledermann was his editorship of the *Journal of the London Mathematical Society* (1968-71) and of the *Bulletin of the London Mathematical Society* (1974-77). He served as Vice-President of the London Mathematical Society from 1971 to 1977. He was the chief editor of the *Handbook of Applicable Mathematics* which consists of nine volumes, an index volume and a number of guide books. This project, again very much in line with Ledermann's approach to mathematics, is designed for "professional adults" who "find themselves needing to understand a particular mathematical idea... will then be able to turn to the appropriate article in the core volume ... and find out just what they want to know." Another important contribution by Ledermann was his work as an external examiner: he served terms at Edinburgh, Glasgow, Keele, Canterbury, Southampton, Birmingham, Wales, the Open University and the National University of Ireland.

For nearly twenty years after his retirement, Ledermann continued to live at Hove near the University of Sussex. For many of these years he continued to teach at Sussex, giving both tutorials and seminars. He continued to publish research articles on his favourite topic of matrix theory, for example *A note on skew-symmetric determinants* (1993), but he also wrote several fascinating historical papers on Issai Schur. In 1997 he and Rushi moved to Highgate in North London, to be closer to their son and his family. One of the difficulties with this move was Rushi Ledermann's requirement that their London home had a room for two pianos, as had their Hove home. Even in his nineties, Ledermann continued to publish interesting articles about the life and work of Issai Schur. Rushi died on 15 June 2009, about three weeks after her husband. They are survived by their son Jonathan.

Recognition of Ledermann’s work included his election to the Royal Society of Edinburgh in 1944 and an honorary doctorate from the Open University in 1993.

Edmund Robertson

*Walter Ledermann PhD(St Andrews), DSc(Edinburgh), HonDUniv (Open University). Born 18 March 1911, Elected FRSE 6 March 1944, Died 22 May 2009.*