

## МАТЕМАТИЧЕСКАЯ ЖИЗНЬ

ABRAHAM ROBINSON (1918–1974)

*On the 95th anniversary of his birth*

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This is a short biographical sketch and tribute to Abraham Robinson on the 95th anniversary of his birth.

This year, the world mathematical community recalls the memory of Abraham Robinson (1918–1984), an outstanding scientist whose contributions to delta-wing theory and model theory are the most convincing proofs of unity between pure and applied mathematics. Robinson created nonstandard analysis which is one of the most controversial, marvelous, and intriguing applications of logic to the core of mathematics.



### **The Life's Signposts of Abraham Robinson**

Abraham Robinson was born on October 6, 1918 in Lower Silesia at a small Prussian town Waldenburg — today this is Wałbrzych in Poland (see [1–3] for biographical details). In America Abraham was lately abbreviated as Abby.

Abraham, Abby, received the name in honor of his father who had died young not long before the birth of his younger son. The surname was written “Robinsohn” those days. Abby’s father was a hebraist, talmudist, and zionist. Abby’s grandfather on the mother’s side was also a talmudist. Abby’s uncle Isac was a famous and successful surgeon, and Abby together with his elder brother Saul spent summers at Isac’s home near Vienna.

In 1925 Abby’s mother, Lotte Robinsohn, moved with her two boys to Breslau, the capital of Silesia, where there was a large Jewish community. The brothers learned in a Jewish private school founded by Rabbi Max Simonson, who took great care of the junior Robinsohns, remarking that “the big boy was an extremely gifted child, but the little one was a genius.”

After Hitler seized power in 1933, Robinsohns emigrated to Palestine. The family settled in Jerusalem, where Abby went to the Rehavia Secondary School, appraised with the excellency of his Hebrew. He and his brother enlisted into Haganah, the illegal organization for defence against Arabs. In due time Haganah turned into a basis of the Army of Defense for Israel (Tzahal).

In 1936 Robinson entered the Einstein Mathematical Institute which was actually the Mathematics Department of the Hebrew University of Jerusalem. His mentor was Abraham Fraenkel.

In 1938 the first paper of Abby appeared in the *Journal of Symbolic Logic* (with h in the author's surname). In January of 1940 Robinson and his companion Jacob Fleischer moved to Paris where Abby enrolled in Sorbonne. But the Germans occupied Paris in June, and Abby together with Fleischer escaped to England through Bordeaux. In England he joined the Free French that was collected by de Gaulle. He became a sergeant of the Free French Air Force. Although Abby was a subject of the British Crown his German origins had hampered his entrance into the British Army for a time being. Miraculously enough, Abby's merits came into play. He had helped a familiar French Captain to make a memorandum on aircraft wings for the Ministry of Aircraft Production, and he was soon reassigned to the British Air Force and transferred to the Royal Aircraft Establishment in Farnborough as an assistant (grade 3) in the British Ministry of Aircraft Production.

In December of 1942 Robinson wrote to his supervisors in Jerusalem that he had decided to participate in the general struggle against Fascism and apply his knowledge in applied mathematics to this end. He remarked that there was no effort for him to turn to applied problems. Robinson addressed the problem of comparison between single-engine and twin-engine planes for which he suggested an analog of the variational method by Ludwig Prandl. He also worked on the problem of structural fatigue and collapse of a flying boat.

In 1944 Robinson married Renée Kopel, a fashion photographer. Abby lived with Renée up to his terminal day.

Robinson was a member of the group studying the German V-2 missiles as well as a mission of the British Intelligence Objectives Subcommittee which concerned intelligence gathering about the aerodynamical research in Germany. In 1946 Robinson returned to Jerusalem to pass examinations for the Master degree. The results were as follows: "physics good, mathematics excellent." In this short period Abby worked together with Theodore Motzkin.

In 1946 the Royal College of Aeronautics was founded in Cranfield near London. Robinson was offered the position of a Senior Lecturer with salary 700 pounds per year. It is worth mentioning that Robinson was the only member of the teaching staff who learned how to pilot a plane. In Cranfield Abby became a coauthor of delta-wing theory for supersonic flights, and in 1947 he learned Russian in order to read the Soviet scientific periodicals.

To gain the PhD degree, Robinson joined the Birkbeck College which was intended for mature working students and provided instructions mainly in the evening or on weekends. Abby's supervisor in the college was Paul Dienes, a Hungarian specialized mainly in function theory. Dienes instigated Abby's interest in summation methods (which resulted lately in Abby's work with Richard Cooke who also taught in the Birkbeck College). Dienes was a broad-minded scientist with interests in algebra and foundations. In 1938 he published the book *Logic of Algebra*, the topic was close to Abby's train of thoughts. In this background Robinson returned to logic and presented and maintained the PhD thesis "On the Metamathematics of Algebra" in 1947.

In 1951 Robinson moved to Canada where he worked at the Department of Applied Mathematics of Toronto University. He delivered lectures on differential equations, fluid mechanics, and aerodynamics. He also supervises postgraduate students in applied mathematics. Abby worked on similarity analysis and wrote "Foundations of Dimensional Analysis" which was published only after his death in 1974.

Robinson was the theorist of delta-wing, but his Farnborough research in the area was highly classified. In Toronto Robinson wrote his *magna opus* in aerodynamics, *Wing Theory*,

which was based on the courses he delivered in Cranfield as well as on his research in Canada. Robinson invited as a coauthor John Laurmann, his former student in Cranfield. The book addressed airfoil design of wings under subsonic and supersonic speeds in steady and unsteady flow conditions. James Lighthill, the creator of aeroacoustics and one of the most prominent mechanists of the twentieth century, appraised most of the book as “an admirable compendium of the mathematical theories of the aerodynamics of airfoils and wings.” Robinson performed some impressive studies of aircraft icing and waves in elastic media, but in the mid-1950s his interest in applied topics diminished had been fading. Robinson continued lecturing on applied mathematics, but arranged a seminar of logic for a small group of curious students.

In 1952 Robinson participated in the second Colloquium on Mathematical Logic in Paris. He made a memorable comment on the about the “wings of logic.” Louis Couturat stated that symbolic logic gave wings to mathematics, which involved the objection by Henry Poincaré that instead of giving it wings logic had only put mathematics in chains. Robinson rebuffed that however great the mathematician Poncaré may had been he was wrong about logic.

The Summer Institute in Logic held in Cornell was one of the most important events for Abby in 1957, when he had already sought for a job beyond Canada. Paul Halmos was the initiator of this gathering under the auspices of the American Mathematical Society. He wrote to Edward Hewitt who supervised summer in the AMS that logic is a live subject developing rapidly without any support from “an admiral of the navy or a tycoon of industry.” Leon Henkin and Alfred Tarski backed up Halmos’s proposal. The meeting in Cornell marked the start of the rapid progress of logic in the USA. Robinson delivered three lectures on relative model completeness and elimination of quantifiers, on applications of field theory and on proving theorems “as done by man, logician, or machine.” It is curious that Halmos had proclaimed himself to be a “logician *humoris causa*.” Perhaps, his future invectives against nonstandard analysis demonstrate this status of his [4, p. 202–206].

In 1957 Robinson had left Canada and returned to his *alma mater* in Israel, where he delivered the compulsory courses on linear algebra and hydrodynamics and a special course on logic. In 1959 he was invited to read a course in fluid mechanics in the Weizmann Institute. Although Abby’s contribution to applied mathematics was fully acknowledged, the place of his studies in the area had slowly faded out. But Robinson never lost his admiration of applications. Alec Young, a specialist in wing theory, remarked that everyone felt that “the applied mathematician in Abby was never far away,” ready to meet any enticing challenge of praxis. After retirement of Fraenkel, Robinson became the dean of the Mathematics Department of the Hebrew University of Jerusalem.

In 1960 Robinson spent a sabbatical in Princeton. At the 1960 International Congress for Logic, Methodology, and Philosophy of Science he made the talk “Recent Developments in Model Theory” in which he gave a comprehensive survey of the pioneering works by Anatoly Maltsev, thus opening them in fact to the logicians of the USA. Robinson strongly emphasized the importance of the Maltsev studies demonstrating how the direct application of model theory led to particular algebraic results.

Soon Robinson was invited to make a plenary talk at the silver anniversary meeting of the Association for Symbolic Logic which took place on January 24, 1961. This date has become the birthday of nonstandard analysis. In summer of 1961 Robinson had been invited to work in the University of California, Los Angeles (UCLA), where he moved in July, 1962. One of the first scholars who shared the ideas of nonstandard analysis was Wim Luxemburg, an outstanding specialist in functional analysis who primarily studied Banach lattice theory [5], [6]. In may of 1962 Robinson wrote to Luxemburg: “For some time now I have been thinking about problems in Functional Analysis but so far as I can see our activities also may intersect

there. Altogether, so far as my standard duties permit, I am now living in a non-standard mathematical world..." That was the matter he lived up to the end of life.

Robinson tried to demonstrate to richness of the new ideas in most diverse problems. He wrote on the technique of nonstandard analysis in theoretical physics, studied nonstandard points on algebraic curves, developed applications of the tools to large exchange economies, to integration of differential equations, to summations methods, and so on [7–16].

In the 1960s Robinson ranked as one of the most popular figures of the mathematical community. In 196 he was in the center of attention of the participants of the first international conference on nonstandard analysis which was arranged by Luxemburg in Caltech. In 1967 Robinson's book [8] was translated into Russian. But his *magna opus* on nonstandard analysis was never published in Russian partly in view of the rise of antisemitism in the academic community of the USSR in those years.

In 1968 Robinson was invited by Nathan Jacobs to leave UCLA for Yale, where Abby became a tutor of a large group of young logicians. In 1970. Abby made an invited plenary talk at the International Congress of Mathematicians in Nice on "Forcing in Model Theory." In 1971 he received Sterling Professorship, delivered a Hedrick lecture at the summer meeting of the Mathematical Association of America, made a talk at the Fourth International Congress for Logic, Methodology, and Philosophy of Science in Bucharest, etc. In 1972 Abby was elected to the American Academy of Arts and Science, and in 1973 the Dutch Mathematical Society decorated Abby with the Brouwer Medal.

The contributions by Robinson were highly appraised by the logic genius of the twentieth century Kurt Gödel who saw Robinson as his successor in Princeton. Gödel wrote: "there are good reasons to believe that nonstandard analysis, in some version or other, will be the analysis of the future", remarking that "his theory of infinitesimals and its application for the solution of analytical problems seems to me of greatest importance" (see [17]). Unfortunately, Robinson could not move to Princeton. In November of 1973 Abby had begun to feel strong stomach pains, and the doctors found a nonoperable cancer of the pancreas. Robinson passed away on April 11, 1974 at the age of 55.

Humankind will never waste out its intellectual treasures. Thus there is no doubt that the Gödel forecast of the future of nonstandard analysis will turn out prophetic, and some version of nonstandard analysis will take place of the classical differential and integral calculus of today. Differentiation as search of trends and integration as prediction of future from trends are immortal technologies of mind. New technologies are awaiting humankind which will use the whole of mathematics in portions incomprehensible today. This will be the analysis of the future Gödel had written about.

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#### АБРАХАМ РОБИНСОН (1914–1974)

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Краткий обзор биографии А. Робинсона и истории создания нестандартного анализа в связи с 95-летием со дня его рождения.