In memoriam Klaus Krickeberg (1929–2025)

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On 27 November 2025 the distinguished mathematician and outstanding teacher Professor Klaus Krickeberg passed away at the age of 96. His broad scientific interests concerned the fields of analysis, martingales, stochastic geometry and point processes, and moreover epidemiology and medical statistics. To him mathematics was a reflection of reality, in which he developed gradually from the abstract to the concrete. Geometrical insight is visible in all his work.

1 Klaus Krickeberg's life

Klaus Krickeberg left a lasting impression not only in his scientific work but also on everyone who knew him: family, friends, students, and colleagues. Science was a defining part of his life, but it never stood alone. He cared deeply about books, languages, history, and politics as well. He was versatile, modest, often humorous, and always ready to help. Above all, he was authentic, whether he was speaking at a stochastics congress, discussing healthcare in Vietnam, enjoying a meal with friends, or repairing his summer house in the Auvergne.

His life spanned ninety-six years. There were decades of political upheavals, wars, and global events of profound significance, as well as technological turning points. He lived through all of this with a kind of inner compass. From an early age, he showed an unusual clarity of mind and the talents that later shaped his work in research and teaching.

Born in 1929 in Ludwigslust, Klaus grew up in a medically oriented family. His father was a radiologist and his mother a medical technical assistant. Three years later his brother Dieter was born. When Klaus was four, Adolf Hitler and the Nazi Party came to power. At home, the family rejected the regime, but the children learned early that political criticism could not be voiced openly.

His intelligence became evident early on. After only three years of primary school in Berlin, he skipped the fourth year and entered the Collège français, a secondary school founded in 1689 for the children of Huguenot refugees, among them his maternal ancestors. Classes were taught in French, and this is where his lifelong connection to France began. He later taught for twenty-five years

At a meeting of the Oberwolfach Committees 2016. (© Gerd Fischer, source: Archives of the Mathematisches Forschungsinstitut Oberwolfach)

at the René Descartes University in Paris and, until two years before his death, spent his summers at his house in the Auvergne.

Even during the Nazi era, the Collège maintained a relatively open spirit, quite different from the surrounding dictatorship. As air raids on Berlin intensified, the pupils were evacuated to Züllichau, today Sulechów in Poland. There Klaus repaired a radio so that his teacher and classmates could listen to the BBC. They gathered in the teacher's room to hear news from what they called the free world.

In early 1945, as the war was ending, Klaus left Züllichau with his headmaster's permission and travelled with his brother to Ingolstadt, where his mother's hospital had been relocated. He narrowly escaped conscription, having turned sixteen on 1 March 1945. When American troops arrived, he knew enough English to point to the building and say, "That is a hospital." He did not learn languages for display. He learned them because he wanted to use them.

School resumed in Berlin later that year. Klaus completed his secondary education in 1946 and began university studies that autumn. At first, he chose physics, but he soon realised that mathematics was what truly interested him. The lectures of Erhard Schmidt impressed him deeply. Years later he still described them

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as "the most wonderful lectures I have ever heard, delivered entirely from memory." After that, his path was clear.

The post-war years were difficult. There was hunger and cold, and life was not easy. Nevertheless, he completed his studies in 1951, earned his doctorate at twenty-three, and soon after completed his habilitation. By twenty-nine, he had become one of the youngest professors of his time. His first professorship was in Würzburg. Later he taught for many years as a full professor in Heidelberg.

His work took him to many countries. He spent extended periods in the United States, first on a Fulbright scholarship, and later an academic year in Aarhus. He did not like idleness. He worked wherever he happened to be, on trains and ships, in waiting rooms and hotel rooms. And if he was not working, he was learning languages. Before moving to Denmark, he learned Danish. Before travelling to Cuba with his French colleague Didier Dacunha-Castelle, he learned Spanish so that he could lecture in Havana and speak with local mathematicians. For conferences in the Soviet Union, he learned Russian. For him, language was simply the way to meet people directly.

This openness led to many encounters. He met and collaborated with Kolmogorov. In Latin America, members of an indigenous community once offered him a ride on their truck, surprised that a European treated them without distance. In Cuba, he sat on the beach with Fidel Castro and spoke with him. In 1973, he was in Chile shortly before the coup of 11 September, at a time when the tension could already be felt.

Political questions mattered to him. Around 1970, he met the French mathematician Laurent Schwartz, who had written an appeal against the American war in Vietnam. Klaus was the only West German mathematician to sign it. From then on, Vietnam became increasingly important to him.

Through one of his Heidelberg students, Xanh, in 1974 he travelled by train to Vietnam to teach mathematics in Hanoi. After that, he returned year after year to support Vietnamese scientists. Over time, his commitment expanded beyond mathematics. In the final decades of his life, improving healthcare and health education in Vietnam became a central focus. He worked to strengthen epidemiological teaching, co-authored books with Vietnamese colleagues, gave lectures, and organised workshops.

His private life was equally full. He married twice and had five children, later grandchildren and great-grandchildren. The last thirty years of his life he spent with his partner Helga, who accompanied him on his journeys to Vietnam and supported his work.

Work was his life. It stayed central to him until the very end. Each morning at home began at his desk. Those hours were reserved for concentration. He worked slowly and carefully and finished what he had set out to do. In his final months, when failing eyesight and hearing made reading and writing impossible, he felt the loss deeply. "It is terrible that I can no longer work" he said.

2 The Bielefeld plan of mathematisation of other disciplines

When Krickeberg accepted a position in Bielefeld in 1971, some of his colleagues and friends, his students and staff may have wondered why such a productive and renowned scientist would leave a leading university in mathematics and natural sciences such as Heidelberg for what then still was a small academic centre such as Bielefeld.

The answer can be found in a 1966 memorandum commissioned by the state government and drafted by sociologist Helmut Schelsky jointly with former Minister of Education Paul Mikat, which henceforth served as the official basis for the establishment of the new University of Bielefeld. In the *structural features* of the new university, the authors emphasised the focus on promoting the mathematisation of the individual sciences. This distinct feature of Bielefeld University was continued year after year in academic committees in Bielefeld and repeatedly reaffirmed by the state government: "One of the university's focal points is mathematisation as a method in the sciences, i.e., reach into practical applications of mathematics to non-mathematical problems."[1]

Krickeberg's ideas, on the other hand, were always very down to earth and concrete; he needed a continuum of competencies:

(I) Firstly, he needed sufficient personal in mathematics to provide advice and assistance to researchers in other disciplines and to teach the necessary basic courses in applied mathematical areas (such as probability theory, statistics, dynamical systems, basis types of partial differential equations, shape and pattern formation, frequency analysis, symmetries, selected algorithms) both within the curricula for mathematics and the curricula of the individual subjects.

(II) He also needed mathematicians who were willing to thoroughly familiarise themselves with areas of application in order to find applications for deep-rooted and perhaps esoteric seeming purely mathematical results.

(III) Finally, regarding hiring, e.g., in biology, chemistry, economics, sociology, psychology, linguistics, and history, Krickeberg suggested that applicants with substantial experience with mathematical tools like stochastic methods, modelling of dynamical systems, algebraic analysis of symmetries and algorithms, or numerical simulation especially should feel invited.

All of this was already included in general terms in the structural characteristics and had been promised to Krickeberg. Research and teaching in mathematisation were to be achieved through research funding and, in particular, personal policy strictly oriented towards this goal. Mikat and Schelsky had based their approach on their experience with US research funding.

At the same time, however, they had also advocated in the structural characteristics for extreme preservation of the Humboldtian European tradition of strong autonomy for university committees.

[1] Cf. Grußwort of K. P. Grotemeyer in [1].

This was realised, for example, with a close focus on academic excellence and international recognition in narrow and narrowest circles. Hence nothing came of the targeted focus on mathematisation. Nothing was realised. It all remained on patient paper.[2] After only three years, Krickeberg therefore accepted a call to Paris.[3]

3 Scientific work and its application

Mathematics

The subject of his doctoral thesis in 1952 were the Gauß–Stokes integral theorems, published in [4]. Part I was motivated by the desire *to obtain the classical Gauß–Green formula in* $\mathbb{R}^d$ *under conditions that are necessary, too.*[4] Part II contains *the first definition and study of locally Lipschitzian manifolds, which were to be investigated in the sequel by several topologists.* Stokes' theorem is proved for differential forms on such manifolds under minimal assumptions. Part III is purely historical. *It traces the ideas underlying the proofs of the various forms of the Gauß–Stokes theorems, starting with early papers by Lagrange (1760), Gauß (1813), Green (1828), Ostrogradsky (1831 and 1838), and Stokes (1854).*

Krickeberg took up again the Gauß–Green theorem in the influential paper [6], but *under a very different angle, viz. via distributions in the sense of Laurent Schwartz. As a main tool it employed the decomposition of measures that was to play once more a decisive role in the solution given in* [9] *of a problem formulated by Rollo Davidson.*

In the 1950s, Krickeberg also spent a year in Illinois in order to work with Doob. *I still vividly remember my first meeting with Doob in his office in the University at Urbana, Ill. When I presented my results to him he said 'Oh, that's interesting' and suggested that I publish them in the Transactions of the American Mathematical Society* [5]. The work in question contains the result which now is called *Krickeberg decomposition* in martingale theory.

Paper [8] was motivated by a problem stated by Eberhard Hopf in Chapter 17 of his classical book on ergodic theory. *While the so-called baker's transformation in the unit square was well understood, and in particular known to be mixing, the nature of the corresponding transformation in the entire plane was hardly elucidated and the problem of its mixing properties was open.* The main contribution of this paper is twofold: *Firstly, it was recognized that the natural setting for defining mixing properties of transformations (endomorphisms) of measure spaces with* infinite *total measure are* topological *measure spaces, not pure (abstract) measure spaces, and the endomorphisms in question are to be not only measure preserving but also almost everywhere continuous.* The second main contribution of [8] is *the construction of isomorphisms between a subset Y of the plane endowed with (infinite) Lebesgue measure and the measure space* (X, m) *derived from a suitable Markov chain as above, such that, for example, the baker's transformation in Y corresponds to the shift T in X. By applying known results from the theory of Markov chains to T, one finally obtains a precise description of the type of mixing including the ergodic index of the baker's transformation.*

In the 1970s, Krickeberg became intrigued with stochastic geometry[5] and its integral-geometric foundations,[6] and more generally, point processes and the statistical analysis of such processes, in particular oriented hyperplanes in d-dimensional space $\mathbb{R}^d$. Together with R. Ambartzumian, Davidson, D. G. Kendall, Matheron and Papangelou, he is one of the founders and a recognized master of these new fields. (Cf. [3, 16].)

The problems considered arise if one does not specify the distribution of the underlying process in advance, but requires instead certain geometrical properties, in particular invariance properties, and then investigates their implications on the structure of the distribution. This development was essentially initiated by Rollo Davidson's thesis.

Krickeberg's main achievements, which were tremendously influential, can be found in [9, 10]. In [9] he used the method of decomposition of measures, used already in [6], to solve a problem posed by Rollo Davidson about the correlation measure of a second-order line process in the plane.

Davidson has also stated a conjecture to the effect that every non-degenerate strictly stationary second-order line process in the plane is a Cox (doubly stochastic) process. Kallenberg constructed a counterexample, but Davidson showed that *for every second-order line process with stationary correlation measure which has a density, there exists a Cox process with the same correlation measure.* This was extended by Krickeberg in [10] to higher-order point processes in a fairly general space X and an equally general transformation group G acting in X: *Let k be a positive integer. Then for any point process in X with a locally finite G-invariant k-th moment measure there exists a Cox process that has the same k-th moment measure.*

[2] At least, Krickeberg brought together a multidisciplinary mathematisation commission, which was intended as an advisory body for tenders and appointments and, in a series of hearings on the role of mathematics from the perspectives of the individual sciences, qualified for this task, even though it was not involved in a single personal decision. (See [1].)

[3] https://www.math.uni-bielefeld.de/chronik/mathematisierung.php, last section with Krickeberg's own recount (accessed 6 February 2026).

[4] The texts in italics are citations from Krickeberg [13].

[5] We cite from Santaló's book *Integral Geometry and Geometric Probability* [16]: "In a symposium on integral geometry and geometric probability held at Oberwolfach (Germany) in June 1969, D. G. Kendall, K. Krickeberg, and R. E. Miles suggested the term *stochastic geometry* to indicate precisely those contents of geometry and group theory that are in a sense related to stochastic processes."

[6] Rooted in the approach of Blaschke and Santaló to integral geometry.

The statistical analysis of point processes was treated in the book [11].

Mathematical teaching

Krickeberg's teaching reached a wide audience by means of locally published notes written for his lectures in Chile, Cuba or Vietnam and always in the local language. Here he was able to recast complicated and unarranged material in an accessible and elegant form, thereby setting clear lines for future research.

But also by means of his three books on probability and statistics (cf. [7, 12, 15]). The first, written in 1963 in Heidelberg, was one of the first books on probability theory in Germany after the Second World War and highly appreciated as a modern and rigorous text for students in mathematics of only two hundred pages. The second book, written in Bielefeld, is an introduction to elementary probability and statistics; as such, it was the first propedeutic book in Germany which then lead to similar changes of the probability curriculum in other German mathematical faculties. The third, written in French language at the university René Descartes in Paris, develops elementary statistical methods for students of mathematics or physics having a certain mathematical culture.

Epidemiology and public health

The following information about Krickeberg's achievements in public health and epidemiology and his ties to Vietnam are partly based on his unpublished talk at the Kallenberg Workshop in 2013.

The contacts with two Vietnamese physicians changed his scientific interests completely. In the summer of 1978 he went to Hanoi to work with the Hygiene Institute. He presented a memorandum on how mathematical work in the institute might be organised. In winter 1979–1980 he gave a course on sample survey methods at the General Statistical Office, probably the first course on that subject ever given in Vietnam.

He got a grant from the French Ministry of Foreign Affairs for a program over ten years on mathematical methods in health in Vietnam. It started in 1981 and consisted of two parts:

(1) Seminars for members of the health system on all mathematical aspects of their work. They were taught by some French colleagues and himself and took place in all institutes of the hygiene and epidemiology network, from Hanoi down to Ho Chi Minh City.
(2) His work with a group of four mathematicians, selected by NIHE (National Institute of Hygiene and Epidemiology) for the purpose of "mathematisation" of public health, especially of statistical approach. It dealt with concrete and urgent practical problems as they arose and at these occasions he pointed out to them the underlying general ideas, mainly from epidemiology.

He told himself: "First you have to learn that stuff yourself." Therefore, he offered to his students of applied mathematics in Paris a course on epidemiology in the wide sense, including clinical epidemiology and in particular clinical trials. It comprised six hours a week of theory and practice during the whole academic year. There was a lot of statistics in it but also for example discrete modelling in population genetics and modelling via differential equations of the evolution of epidemics, both deterministically and stochastically. He taught this course more than a dozen times until his retirement in 1998. It turned out that the students who had followed it successfully were very much sought after in the French health system. They readily found positions in big hospitals, health administrations and medical and public health research institutes.

He made up his own definitions of public health and epidemiology: *public health* is the entirety of theoretical and practical activities that are related to health and deal with populations as a whole but not specifically with their individual members. *Epidemiology* is the science of the distribution of diseases and of similar health-related features in human populations and of the factors that influence such distributions.

This shows, in the first place, that epidemiology is to a large extent statistics, even fairly advanced mathematical statistics. In the second place the two definitions imply that epidemiology is part of public health.

Krickeberg became a UNICEF advisor in Vietnam and Cambodia until 1987 for various topics in primary health care. It was a most interesting experience because it meant much fieldwork, that is, visits to village health stations and families.

In 1994 the German "Society for Technical Cooperation" (GTZ) hired him for its program on family planning in Vietnam. There was again some non-trivial mathematical statistics in it, namely sample survey methods and demography. Finally, he worked in 1999 and again in 2004 in the European–Vietnamese "Health Systems Development Program" on "Health Information Systems." All of this practical work taught him that rigorous thinking following the ways of mathematics is of utmost importance, even in seemingly simple fieldwork.

In 2005 Krickeberg went again to Vietnam, for the first time as a tourist, and he visited his old friend Hoàng Thny Nguyên who had retired from the directorship of the National Institute of Hygiene and Epidemiology. He told him that one of the smaller medical universities in the North-eastern region of Vietnam, Thai Binh University of Medicine and Pharmacy, wanted help with the teaching of public health to its students.

He started a program, which in the course of time came to cover all medical universities or faculties of Vietnam except the two big centres Hanoi and Ho Chi Minh City. It was funded by the German foundation "Else Kröner-Fresenius-Stiftung." In the first phase it focused on the teaching of public health to medical students during their six years of basic studies. In Vietnam this basic medical curriculum includes in fact courses on most topics of

public health, which is very reasonable because physicians in the countryside or in small cities also have to do a lot of work in public health, for example managing a village health station, promoting health education, prevention including classical hygiene.

In the first phase of their program they widened the horizon of the lecturers and made them work more independently and more rigorously. They did it in two ways. Firstly, they ran yearly workshops in Vietnam where they did not teach the participants any particular matter but had some of them present their own work. Above all, they discussed and worked together on some topic, for example on the structure of a curriculum or on new teaching methods such as "population-side teaching." Excursions to small health facilities and rural families were always included.

Secondly, they wrote new texts on many topics together with Vietnamese lecturers. They always started with a critical analysis of the existing text. In the new text, examples, applications and case studies were mostly taken from the Vietnamese health system; foreign situations were being compared with the corresponding Vietnamese ones. All books are bilingual: Vietnamese and English version appearing in a single volume. In order to accommodate all of these books and to make it clear that they form a coherent body of texts, Krickeberg founded a book series in the Medical Publishing House of Hanoi; it is called "Basic Texts in Public Health."

The second edition on epidemiology, key to public health [14], appeared in 2019, which Krickeberg considered his best book. From the back cover: "The organization of the topics by didactic aspects makes the book ideal for teaching. All examples and case studies are situated in a single country, namely Vietnam; this provides a particularly vivid picture of the role of epidemiology in shaping the health of a population. It can easily be adapted to other developing or transitioning countries."

Krickeberg, together with Booß-Bavnbek, published an article about Covid-19 [2]. Their main point is the critical need for systematic mathematical modelling to combat the Covid-19 pandemic. The authors argue that, in the context of Covid-19, it is essential to take into account spatial inhomogeneities (hot spots, super-spreaders and the functioning of local health authorities) in order to understand chains of infection, make predictions and guide political decisions. They base their analysis on principles of classical medical statistics and descriptive epidemiology. Their arguments utilize demographic data and established mathematical structures for infection dynamics to evaluate prevention strategies and vaccine efficacy.

4 Honours received by Klaus Krickeberg

Klaus Krickeberg became a fellow of the Institute of Mathematical Sciences in 1968. He was elected into the International Statistical Institute (ISI) in 1971, was member of its Council 1985–1989 and chairman of its committee for the development of statistics in developing countries 1987–1991. He was president of the Bernoulli Society for Mathematical Statistics and Probability 1977–1979, contributed to the establishment of regional committees in Latin America and East Asia and was chairman of the program committee of the first world congress of this society in Tashkent in 1986. In 1983, he was elected into the German National Academy of Sciences Leopoldina.

Klaus Krickeberg received an honorary doctorate (Dr. rer. soc. oec. h.c.) from the Faculty of Social and Economic Sciences at the University of Vienna in 1990. This honour recognized his outstanding scientific contributions as a mathematician, particularly in the fields of probability theory and statistics, as well as his interdisciplinary work. He was elected as a fellow of The World Academy of Sciences (TWAS) in 1994.

He has received several distinctions for his activities in Vietnam. In the year 2009 it was the Medal of the Ministry of Health for Contributions to the Health of the Population. Then, in 2011 the National University of Sciences of Ho Chi Minh City bestowed on him its honorary doctorate for his work in mathematics, and in 2015 the Thai Binh University of Medicine and Pharmacy named him honorary professor. In 2018, he received the Friendship Order, the highest order bestowed by the Vietnamese government on foreign individuals by the President of Vietnam for "many positive essential contributions to the development of the Vietnamese health sector."

There was also a distinction that he received already in the early 1980s. One morning a house messenger who arrived at the same time as he by bicycle at the gate of the National Institute of Hygiene and Epidemiology in Hanoi said to him in Vietnamese "Krickeberg is a Vietnamese man."

At his funeral service, leading Vietnamese authorities, including the Vietnamese Consulate General, expressed their condolences and honoured him as a bridge figure in German–Vietnamese friendship. Klaus Krickeberg's work in Vietnam was much more than an advisory activity; it has been a lifelong mission to use statistical science as a tool for social justice and health.

The International Statistical Institute (ISI) dedicated a detailed "In memoriam" article to him, emphasising his worldwide importance for mathematical statistics.

5 Krickeberg, a humanist

Galen, a famous Greek physician during the Roman era, believed that a good doctor is a philosopher. On the other hand, according to Pythagoras, a mathematician is also a philosopher. Hence, a mathematician could also contribute to "healing" people. Krickeberg was such a person. His applied mathematics could help prevent disease, saving thousands of lives. Mathematics is the central point in sciences, theoretically and practically, to understand natural and social phenomena and bring them under control, and in the case of public healthcare, to bring the spread of infectious diseases under

Klaus Dietz (left), Klaus Krickeberg, Nguyễn Xuân Xanh, Hans Zessin; photographed by Helga Zeile. This group came together in Da Lat (Vietnam) on 1 March 2009 for Klaus Krickeberg's 80th birthday.

control. While doing this, Krickeberg's activities lay the foundation for statistical mathematics in Vietnam and to improve education in this area. He has uncountable students during his fifty years of work in Vietnam. He is a great teacher.

To improve health education, Krickeberg created a publishing group of young active Vietnamese colleagues, mathematicians, and well-trained doctors, to work out a very ambitious series of textbooks with state-of-art scientific knowledge replacing outdated ones, from mathematics and statistics, epidemiology, health education to population science and public health, environmental health and nutrition, for the purpose of teaching. That would be a great program to modernize the contents of public health completely with great impact for the future. That would be a "revolution" in knowledge and education in public health for Vietnam, showing how to come to terms with *esprit de science*. That shows the competence and authority of Krickeberg.

Krickeberg did this with the ideal and vision of Renaissance humanists: namely to create knowledge and pass it on to future generations, with a high sense of social responsibility, to help people live with health, dignity and social progress.

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