

Eberhard Zeidler 1940–2016

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Eberhard Zeidler passed away on Nov. 18, 2016 after a long illness. The main theme of his life was a grand vision of the unity of mathematics and physics, towards which he worked with several series of impressive and encompassing monographs, and towards which he also devoted much organizational energy, culminating in the foundation of the Max Planck Institute for Mathematics in the Sciences in Leipzig.

Eberhard Zeidler was born in Leipzig on Oct. 6, 1940. Leipzig remained his home town throughout his life. There, he attended the Humboldt Gymnasium (High



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School), and upon his graduation in 1959, he was awarded the Lessing Gold Medal. From 1959 to 1961 he studied mathematics at the University of Leipzig, which was called Karl-Marx-University at the time. He had found his call in life, and the enthusiasm for mathematics and physics and their deep relation helped him to overcome difficult times. On Sept. 23, 1961, he was relegated from the university for political reasons and because of his upright personality. He first had to work as a transportation worker and then was drafted to the army. He also took courses qualifying him as a music teacher. During this time, he continued to study mathematics and physics by himself, with the support of this teacher Herbert Beckert. In 1964, he was allowed to resume his studies at the university. He completed his diploma degree in 1967 and went on to receive his PhD degree in the same year with Herbert Beckert, with his dissertation “Über eine Klasse nichtlinearer singulärer Randwertaufgaben der Funktionentheorie mit Symmetrieverhalten” (On a class of nonlinear singular boundary value problems in function theory with symmetry) [47], and in 1970 he qualified as a professor, with the habilitation degree, with his thesis “Zur Theorie und Praxis einer Klasse freier Randwertprobleme der ebenen Hydrodynamik” (On the theory and praxis of a class of free boundary value problems of planar hydrodynamics) [54, 55] (see also [45]).

In 1962, Herbert Beckert had initiated a new theory of permanent waves, by introducing topological fixed point arguments to obtain general existence results for various types of capillary, tidal, and other waves. In a monograph published in 1971 [11], Eberhard Zeidler then developed a general theory for such waves that not only allowed for the efficient computation of the solutions, but also provided the tools for the existence proofs for many other types of waves, as for instance in [12, 19–21, 43, 44] and [1–3] with Klaus Beyer. In 1972 [56], he obtained a new and transparent proof for the Bénard problem in the bifurcation and stability theory of the Navier-Stokes equations. In fact, Eberhard Zeidler quickly became a mathematician who shaped the scientific development in Leipzig, through his original and significant contributions to bifurcation theory [15, 36, 51], free boundary value problems [11, 46], hydrodynamics [18], positive operators [52, 53], Lyusternik-Schnirelman theory [23, 24, 42] and variational inequalities [25], and his approaches to numerical functional analysis [8] with Rainer Schumann, his first Phd student. His axiomatic theory of the mapping degree [17] achieved a level of generality hitherto unknown in the field, and with this approach he could provide a unified treatment of a wide range of results that had formerly been unconnected to each other. Also, the axiomatic method that he developed became a powerful and systematic tool for many other areas of functional analysis. In fact, during these years, he founded the field of nonlinear functional analysis with his impressive books (the original version [48–50] consisted of 3 volumes, but a greatly expanded and largely rewritten English 4-volume version [27–31], including in particular the volume on applications to mathematical physics [31], with more than 3500 pages was later published by Springer). In these books, he systematically developed and combined fixed point theorems, bifurcation theory, convexity theory and monotone operators and applied them to problems of nonlinear partial differential equations, the calculus of variations and optimization, and mathematical physics (classical and quantum mechanics, elasticity theory, thermodynamics, hydrodynamics and the theory of relativity) and mathematical economics. From 1974 to 1996,

Eberhard Zeidler was Full Professor for Analysis at the University of Leipzig. With his work and his research activities, he contributed to the long-lasting tradition of the “Mathematisches Seminar” founded by Felix Klein in 1881. Upon the invitation of Paul Rabinowitz, he then spent a long research visit at the University of Wisconsin in Madison, and in the final years of the GDR he received invitations to almost all of the world’s major mathematical research institutions.

In the later 80s, peaceful demonstrations gained momentum in the GDR, in particular the Monday demonstrations in Leipzig. Such demonstrations in a totalitarian state involved high personal risks, but in spite of those risks, Eberhard Zeidler participated. Eventually, these demonstrations succeeded in triggering the peaceful revolution that led to the collapse of the GDR and the reunification of Germany.

After the fall of the Berlin Wall in 1989, with much energy and courage, he took the initiative for the reconstruction of the University of Leipzig. On June 11, 1990, Eberhard Zeidler, the chemist Cornelius Weiss and the physicist Adolf Kühnel issued a joint statement as an “Initiativgruppe zur demokratischen Erneuerung der Universität” (Initiative Group for the Democratic Renewal of the University), in which they pointed out the political responsibility of the university for the injustice committed against students, employees and university teachers. This declaration demanded that the rectorate, which was still in office after the upheaval of the peaceful revolution, be renewed from bottom to top. When this declaration, despite 250 other signatures from university members, still failed to produce a response, nine days later a letter was issued by ten mathematics professors, calling for the resignation of the rector and the university administration. This was the decisive step towards the actual renewal of the university. This courageous action on the basis of a deep sense of tradition, with an optimistic view of the future and the caring for future generations was characteristic for the entire work of Eberhard Zeidler in science and society.

In the nineties, he completed the books “Applied functional analysis” with part 1: “Applications to mathematical physics” [9] and part 2: “Main principles and their applications” [10]. He also took over the classical “Taschenbuch der Mathematik”, which had been founded by I.N. Bronstein and K.A. Semendjaew in the Soviet Union. A German translation was published in the GDR by Teubner, with a licensed edition also in West Germany. Originally, this book, known as the “Bronstein”, was a basic and widely used reference work for mathematical formulas, but Eberhard Zeidler transformed it over the years into a compendium of modern mathematics, with the help of several collaborators [5, 6, 57]. A first translation into English appeared at Oxford University Press in 2004, as “Oxford users’ guide to mathematics” [32]. Subsequent stages then saw the “Taschenbuch der Mathematik” [41] as well as the 4-volume “Handbuch der Mathematik” [37–40], published by Springer.—His various books were so successful and popular that most of them saw several editions in close succession.

Among his international collaborations, those with colleagues from Poland were particularly intense, see for instance [4], where the relativistic dynamics of the combined particle-field system in renormalized classical electrodynamics was treated.

Thanks to his scientific and personal reputation, Leipzig was chosen as the site of the new Max Planck Institute for Mathematics in the Sciences, the second Max Planck Institute dedicated to mathematics after the Bonn Institute founded by

Friedrich Hirzebruch in 1980, whose initiative and support were also instrumental for the foundation of the new institute. He invented its name, “Mathematik in den Naturwissenschaften” (Mathematics in the Sciences), for him a modern version of Leibniz’ “*theoria cum praxi*”, and this then became also the guiding motto for its scientific work and atmosphere. The institute opened in 1996, with Eberhard Zeidler as a founding director, together with Jürgen Jost and Stefan Müller [7]. Wolfgang Hackbusch joined the institute as the fourth director in 1999. In 2007, Eberhard Zeidler formally retired, but continued to pursue his major scientific project, his encompassing treatise on the mathematics of quantum field theory, with great energy and determination until illness and death eventually prevented him from doing so. His scientific enthusiasm for mathematics and theoretical physics was particularly evident during the years when he systematically collected the material and then started to write this crowning achievement of his scientific life. He could complete three volumes with a total of more than 3000 pages, and it is planned that a fourth volume be completed by Jürgen Tolksdorf, on the basis of his notes. The project carries the subtitle “A bridge between mathematicians and physicists”, and it deals with the mathematical representation and penetration of quantum field theory, and this offers him the opportunity to develop the entire spectrum of pure mathematics and thus the formal structure of theoretical high-energy physics. The first volume “Basics in mathematics and physics” [33] provides a systematic background and develops both what is mathematically rigorously known about quantum field theory, and the successful heuristic schemes in the field. The first part develops tools like distribution and Green functions, Hilbert spaces or Grassmann calculus. The second part explores the functional integral calculus, the response and the operator approach, and also includes a first treatment of gauge theory. The second volume “Quantum electrodynamics” [34] develops renormalization theory, systematically introduces combinatorial methods, and recalls the mathematical strategy of equivalence classes. It then moves from classical mechanics, in particular geometric optics, the principle of critical action and the harmonic oscillator, to quantum mechanics, in particular scattering theory, and from there to quantum electrodynamics, systematically applying all the tools developed in earlier chapters and in the first volume. The third volume “Gauge theory” [35] systematically develops the tools from algebra, representation theory and cohomology and applies them to the cases of physical interest, including Yang-Mills theory and Einstein’s theory of special relativity. The planned, but unfinished fourth volume was intended to treat quantum mathematical physics, including quantization schemes, finite dimensional versions of thermodynamical and quantum fluctuations, then moving via the quasi-finite situation to the continuum limit and renormalization, with a detailed treatment of the non-relativistic as well as the relativistic hydrogen atom. The final parts were devoted to conformal symmetries and string theory, to the operator algebra approach to quantum field theory, and to topological field theory. The plan for the fifth volume was condensed matter physics, in particular with the methods of quantum field theory, and in the final sixth volume, he wanted to describe the state of the art in quantum gravity and string theory.

He was a member of the German Academy of Natural Scientists Leopoldina since 1994, and from 2007 to 2010 he was also Senator and Ombudsman of the Mathematics Section. He was a sought-after member of many scientific advisory boards and

committees. In 2006 he was awarded the Alfried Krupp Science Prize and in 2014 the Teubner Foundation's Science Prize for the Advancement of the Mathematical Sciences. In 2006 he received an honorary doctorate from the Vietnam Academy of Science and Technology in Hanoi.

He also shared his vision of the role of mathematics and the unity of mathematics and physics in several articles, for instance [13, 14, 16, 22, 26], which reached a wide readership. His lectures and seminars always had a great impact on the students, because of the wide perspective they offered, the enthusiasm for mathematics and physics they conveyed, his unmitigated desire for a deep understanding that shone through them, and the combination of clear scientific and moral values and human generosity and warmth that characterized his personality. Hence, many PhD students, postdocs, and researchers were attracted to come to Leipzig. He had a substantial number of doctoral students, several of which became successful mathematicians themselves. Beyond those that formally were his students, there is a large number of scientists who consider him as an important mentor, both as an enthusiastic and deep scientist and as a great personality. These include, among many others, Hoang Xuan Phu who became a professor at the Vietnam Academy of Science and Technology, Rainer Wulkenhaar, professor in Münster, Gert Wanka, professor in Chemnitz, and Johanna Wanka, currently the German Federal Minister of Science and Research.

The human being and the scientist Eberhard Zeidler cannot be separated. He lived for and through science, and at the same time he was able to bring his great humanity to this science. He was able to grasp mathematics and physics in their entirety and in their inner structure and relations like only a few others. His scientific achievement and his intellectual legacy lie less in solving specific difficult problems—although he solved a number of important problems in nonlinear functional analysis and their applications—, but in the great synthesis. Our science often faces the danger of being fragmented into individual disciplines which no longer have anything to say to each other and which no longer understand each other. We therefore need great individuals like Eberhard Zeidler, who see and overlook the unity of science and who can convey it with great passion and enthusiasm.

He has achieved a lot, but he could have achieved even more if the circumstances in his formative years had been better. He, however, never looked back with bitterness on the opportunities he was denied, but rather always looked forward with optimism and enthusiasm to the future.

He leaves behind his wife Christine, whose selfless and great support has been essential for his manifold successes.

His human generosity, selflessness and warm-heartedness, his great dedication to the development of our institute, his enthusiasm for good and deep science, his untiring, never-ending quest for scientific knowledge, his leadership and his visions will forever remain a great source of inspiration for us.

Doctoral students of Eberhard Zeidler

- Rainer Schumann (1979)¹
- Stefan Ackermann (1980)

¹Sadly, Rainer Schumann passed away on July 22, 2017.

- Werner Berndt (1980)
- Amira Costa Ayube (1983)
- Matthias Günther (1983)
- Wolfgang Kliesch (1984)
- Karin Quasthoff (1985)
- Thephavongsa Onh (1988)
- Friedemann Schuricht (1989)
- Klaus Schenk (1990)
- András Dörr (1993)
- Christian Fleischhack (2001)
- Alexander Lange (2003)
- Carsten Wolters (2003)

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