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A New Max-Planck Institute for Mathematics in the Sciences in Leipzig

Jürgen Jost, Stefan Müller, and Eberhard Zeidler

The German Max-Planck Society recently decided to found a Max-Planck Institute for "Mathematics in the Sciences" in Leipzig in the state of Saxony in former East Germany. The official opening ceremony will take place on October 2, 1996. The new institute is the second Max-Planck Institute devoted to the mathematical sciences after the one in Bonn, whose founding director was Friedrich Hirzebruch.

The purpose of the Institute will be to carry out research in pure and applied mathematics, to foster the dialogue between mathematics and the sciences, and to integrate modern scientific advances in the sciences into mathematics. Historic experience shows that problems from physics, chemistry, biology, and other sciences have inspired new developments in mathematics, while mathematics in turn has had a profound impact on these fields. Fourier's analysis of the heat equation, for example, led to the development of harmonic analysis; Gauss's work as a surveyor inspired his theory of surfaces and the development of differential geometry, which now forms the basis of general relativity and the Standard Model in particle physics; Heisenberg's formulation of quantum mechanics accelerated the development of functional analysis and operator theory; research in nonlinear dynamics was partly motivated by and had a strong impact on celestial mechanics; the theory of compensated compactness partly grew out of problems of the binding of atoms; and gauge field theories have deep connections with topology and geometry.

To foster the exchange of ideas, the Institute will have a few permanent positions and a variety of temporary positions for young scientists, as well as an active program of long- and short-term visitors. It is planned to build up some research groups that will work together on specific projects.

Among the visiting positions there will be a particularly distinguished "Sophus Lie Visiting Professorship", for which eminent senior scientists will be invited for one- or two-year terms in order to stimulate the exchange between mathematics and the sciences. The name for this position has been chosen in honour of Norwegian mathematician Sophus Lie (1842-1899), who worked in Leipzig from 1886 to 1898 and whose deep theories of symmetry groups and differential equations have had a profound and decisive influence on the development of twentieth-century theoretical physics.

The main areas of mathematical research will be analysis, geometry, and mathematical physics. A prominent theme will be the theory of nonlinear partial differential equations. Specific topics will include Riemannian and algebraic geometry as well as their interaction with modern theoretical physics (harmonic maps, minimal surfaces, Ricci flow, mean curvature flow, Yang-Mills and Seiberg-Witten equations), mathematical models in materials science (microstructure, homogenization, phase transitions, fracture, interfaces and thin films), continuum mechanics (elasticity, fluid and gas dynamics), nonlinear waves and pattern formation, many-particle systems, phenomena in general relativity, quantum field theory, neural networks, and models of cognition. Most of these models lead to strongly nonlinear partial differential equations, whose solutions typically exhibit singularities as well as complex oscillation and con-
centration effects. In applications these effects manifest themselves as shock waves, defects, turbulence, microstructure, and nucleation. At the same time the analysis of singularities also lies at the heart of many geometric phenomena. A better understanding of singularities and oscillation effects will require a sophisticated combination of modelling and analysis in order to isolate the significant mathematical objects.

Interaction with the sciences will include a broad spectrum of topics, ranging from fields that already have a strong interaction with mathematics, such as particle physics or continuum mechanics, to areas whose mathematicization is just beginning, such as cognition or materials science.

To complement analysis and modelling by numerical simulation, it is also planned to build up a research group in scientific computing.

The Institute plans an active interaction and collaboration with the universities in the region, in particular with the mathematics department of the University of Leipzig. That university has a long and distinguished tradition as one of the oldest German universities. Among its students was Gottfried Wilhelm Leibniz. The modern mathematics department was created by Felix Klein. Other mathematicians besides Lie and Klein who worked in Leipzig include August Ferdinand Möbius, Carl Neumann, Adolf Mayer, Otto Hölder, Paul Koebel, Leon Lichtenstein, Gustav Herglotz, Eberhard Hopf, Bartel van der Waerden, Ernst Hölder, Erich Kähler, Herbert Beckert, and Paul Günther, to name but a few. Famous scientists in Leipzig include Wilhelm Ostwald, Paul Flechsig, Wilhelm Wundt, and Werner Heisenberg. The city of Leipzig has about half a million inhabitants. It is the site of an important international trade fair and prides itself on a rich cultural life.

The Institute will start with a board of three directors consisting of Eberhard Zeidler, Jürgen Jost, and Stefan Müller, with Jürgen Moser as scientific advisor.

Eberhard Zeidler will be the managing director. He was born in Leipzig in 1940. In 1959 he enrolled at the University of Leipzig as a student of mathematics and physics but was dismissed from the university for political reasons between 1961 and 1964. He obtained his Ph.D. in 1967 with Herbert Beckert. In 1970 he became an assistant professor in Leipzig, and in 1974 he was promoted to full professor. He is interested in classical and modern mathematical physics, including fluid dynamics, elasticity theory, and quantum field theory, nonlinear partial differential equations, the calculus of variations, and infinite-dimensional dynamical systems, including bifurcation theory.

Jürgen Jost was born in Münster in 1956. He studied mathematics, physics, economics, and philosophy in Bonn—from 1975 to 1980. In 1980 he obtained his Ph.D. in mathematics under Stefan Hildebrandt. He has been a professor at the Ruhr University in Bochum from 1984 to 1996. In 1993 he was a recipient of the highest German research award, the Leibniz Prize of the DFG (German Research Society). His research interests include Riemannian, Kählerian, and algebraic geometry, in particular in connection with nonlinear PDE and mathematical physics; the calculus of variations; and certain questions in theoretical biology and cognition.

Stefan Müller was born in 1962 in Wuppertal. He studied mathematics and physics at Bonn University, at Heriot-Watt University in Edinburgh, and at the University of Paris, obtaining his Ph.D. with John Ball in 1990. He became a professor in Freiburg in 1994 and at the ETH Zürich in 1995. At the first European Mathematical Congress in Paris in 1992, he was one of the recipients of the award of the Congress for junior researchers. In 1993 he obtained the Max-Planck Prize for his collaboration with Vladimir Sverak. His research focuses on the mathematical foundations of the material sciences, microstructures, micromagnetism, continuum mechanics, singular perturbations, and on the theory of nonlinear PDE and the calculus of variations.

Jürgen Moser, who will act as external scientific advisor, was born in Königsberg in 1928. He was a student in Göttingen from 1947 to 1952 with F. Rellich and C. L. Siegel. In 1952 he obtained his Ph.D. Between 1955 and 1960 he held positions at New York University and MIT. In 1960 he became a professor at the Courant Institute, acting as its director from 1967 to 1970. In 1980 he moved to the ETH Zürich, where he was director of the mathematical research institute (FIM) until his retirement in 1995. For his many distinguished and profound contributions to mathematics (Nash-Moser iteration; KAM theory and its applications to celestial mechanics; Moser iteration technique in PDE; his work on spectral theory, calculus of variations, differential geometry, complex analysis, ...) he was awarded the Wolf Prize in 1994, one of the highest international distinctions in mathematics. He also received the George D. Birkhoff Prize in Applied Mathematics of the American Mathematical Society in 1968, the Craig Watson Medal of the National Academy of Sciences of the USA in 1969, the L. E. J. Brouwer Medal (Groningen) in 1984, and the Georg Cantor Medal of the DVM in 1992. A more detailed presentation of his work and achievements can be found in E. Zehnder, Cantor-Medaille für Jürgen Moser, Jber. DMV 95 (1993), 85–94.