



## PAUL GERMAIN

1920–2009

Elected in 1979

*“For contributions in research and education leading to the development of improved supersonic aircraft.”*

BY ARNOLD MIGUS

**P**AUL GERMAIN, a French scientist of great reputation in the field of mechanics, died on February 26, 2009, at the age of 88. A leader in the field of supersonic aerodynamics for many years, Paul Germain also wrote textbooks and taught continuum mechanics, greatly influencing engineering education in France and abroad.

Paul Germain was born in Saint-Malo, France, on August 28, 1920. His father, who was a soldier during World War I, suffered from the effects of having been gassed, and died when Paul was only 9 years old. Following this premature departure of his father, Paul Germain, the eldest of three children, developed the sense of responsibilities and commitment that characterized him all his life, in an atmosphere of big family solidarity.

Trained as a mathematician at the Ecole Normale Supérieure in Paris, he quickly became interested in fluid mechanics. In 1948 he attended the International Congress of Mechanics in London, where, thanks to Sydney Goldstein, he had the opportunity to meet a large number of talented colleagues and was invited to spend some time in the Department of Applied Mathematics of the University of Manchester, headed in 1949 by Goldstein and in 1951 by his long-lasting friend James Lighthill. His thesis on the subject of conical supersonic flows was published by ONERA (The French Aerospace Lab),

where he was a group leader from 1946 until 1952, and was translated into a National Advisory Committee for Aeronautics technical memorandum. After becoming a senior lecturer at the University of Poitiers, he was invited by Professor William Prager at Brown University for the full academic year 1953–1954 to be a member of the graduate division of applied mathematics, which, as Paul Germain noted, was surprising at that time for a French scientist by its closeness to engineering.

In October 1954, coming back to France he was appointed professor in the chair of “rational mechanics” at the University of Lille. At that time, in France at least, rational mechanics was considered a branch of mathematics, dealing mostly with the application of the Newtonian theory to rigid body motions and Lagrange’s analytical mechanics. Paul Germain noted in his memoirs that his progress in understanding fluid mechanics was then mostly due to his close relations with and good knowledge of the works of Paco Lagerstrom, Saul Kaplun, and Julian Cole, his colleagues during his stay at the California Institute of Technology, and later to the academic year spent by Paco in his laboratory, and also to the two visits in Paris of Milton Van Dyke for one full year each. All of them theorized on asymptotic singular expansions, which Germain came to use frequently. He also benefited much from the long stay of W. Eckhaus in his laboratory, but above all from his collaboration with his former student Jean-Pierre Guiraud.

In 1958, Germain became a professor at the University of Paris, Pierre et Marie Curie, until 1987 and from 1973 to 1985 he was also professor of mechanics at the Ecole Polytechnique. For five years (1962–1967) he left the university to be in charge of aeronautical research in France as general director of ONERA. After leaving this position he went back to research and was invited to Stanford and Berkeley. He became professor emeritus at his university in 1987 and from 1988 until 1992 was president of the International Union of Theoretical and Applied Mechanics.

Germain was elected a corresponding member of the French Academy of Sciences in 1965 and became a full member in 1970. He was elected “perpetual secretary” of the

academy in 1975, with the mission to reform the institution, which he did until the end of his term in office in 1995. Among his many works should be mentioned the *Rapport sur les sciences mécaniques et l'avenir industriel de la France* (Report on the mechanical sciences and the industrial future of France), which had an important influence on the orientation of many people working in mechanics, on scientists in universities and research establishments, on engineers and directors of companies, and on the orientation of long-term programs. One outcome of the report was creation of the *Haut Comité de mécanique* (High Level Committee on Mechanics), of which Germain was the founder and first president. After a lapse of some 15 years, in 1997 the decision was made to join together 20 small scientific and technical associations into a single society, the Association Française de Mécanique (French Association of Mechanics).

Paul Germain was in the 1950s an expert on the theory of transonic flows. He obtained many important new results in the mathematical theory of partial differential equations of mixed types, with the aim of finding a better understanding of the aerodynamical properties of transonic flows. One must also mention his significant contributions to the theory of shocks with Jean Pierre Guiraud, with whom he gave the complete theory of the shock structure—to any order—a question previously studied by Russian and American scientists but erroneously after the second order. He is also the first to have given an extensive analysis of magneto-fluid-dynamic shocks, taking into account the four main dissipative effects. In his personal contributions it may be mentioned his study of shock waves in elastoplasticity and an extension of some of these results to a two-fluid model of a plasma, showing in particular the oscillatory behavior that may exist in the structure of a shock. But his systematic application of the method of virtual power in various fields of continuum mechanics was more important. It must be emphasized that this method gives the possibility, first, to significantly reduce the classical presentation and to clarify it, for instance, for plates and shells, and second, to derive with no ambiguity the general equations of motions for sophisticated materials.

Paul Germain was elected a National Academy of Engineering foreign associate in 1979 and was recognized by many academies, including the American Academy of Arts and Sciences, the Polish Academy of Science, and the USSR (now Russian) Academy of Science.

Paul Germain's name stands extremely high in the literature of theoretical aerodynamics (with important aeronautical applications) treated by advanced mathematical methods. His work as general director of ONERA deepened the impact of his contribution to aeronautics very considerably. His leadership of an important school of theoretical fluid dynamics in the University of Paris, Pierre et Marie Curie, was outstanding. He was recognized as the strongest French research worker in his field. The development of supersonic wing shapes was particularly influenced by his contributions.

I would like to point out some other facets of his exceptional personality. Paul Germain was quietly a man of religious faith. He was a leader of his student Christian youth organization. Much later, in 1986, he became a member of the Pontifical Academy of Sciences. In 2006 he published *Memoirs of a Christian Scientist*, a work that enlightens the route and life of an outstanding figure. A final story about Paul Germain: he was quite perturbed during the academic year 1953–1954 by the statement of a young boy who filled the tank of his car at a gas station near Brown University who told him one day, "Let me be straightforward. A professor is somebody who was put to school when he was five years old and who had not enough imagination to get out." At the end of his life he could find at last the best answer to the young guy's remark by starting from the motto he was at the origin in France: "Mechanics? In the heart of a moving world!" And a professor of mechanics? One of the best spots to look at and to participate in this moving world.

Marie-Antoinette Gardent, his wife, followed him on December 19 of the same year. They had two children and eight grandchildren.

