Jacques-Louis Lions

Grasse, France, 3 May 1928 – Paris, France, 17 May 2001

Title Former President, Academy of Sciences and Professor of Mechanical Sciences, Collège de France and Ecole Polytechnique, Paris, France.

Field Mechanical Sciences

Nomination 4 Oct. 1990

Most important awards, prizes and academies

Academy of Sciences of Paris (1973); Royal Society of Sciences, Liège (1973); Accademia delle Scienze e Lettere, Milano (1977); Academia Brasileira de Ciencia (1979); USSR Academy of Sciences (1982); Royal Academy of Belgium (1986); American Academy of Arts and Sciences (1986); International Academy of Astronautics (1986); Founding Member of the Academia Europaea (1988); Member of the Pontifical Academy of Sciences (1990); Member of the Ukrainian Academy of Sciences (1991); Member of Russian Academy of Sciences (1992); Member of the Chilean Academy of Sciences (1993); Member of the Argentinian Academy of Sciences (1994); Member of the Royal Society (1996); Member of the National Academy of Sciences USA (1996); Member of TWAS (Third World Academy of Sciences) (1996); Member of FORUM France-Japan (1996); Fellow of Tata Institute of Fundamental Research, Bombay (1996); Royal Academy of Sciences of Spain (1997); Portugal Academy of Sciences (1997); Foreign Member of KAST (Korean Academy of Sciences and Technology) (1997); Foreign Member of Academy of Sciences of China (1998); Member of Lincei Academy (1998). John von Neumann Prize (1986); Japan Prize (1991); Harvey Prize (1991); Reid Prize, SIAM (1998).

Summary of scientific research

Linear and non linear partial differential equations; interpolation of function spaces; control of distributed systems; analysis of models in climatology; numerical analysis of partial differential equations; parallelism – decomposition methods.

Main publications

Published Books: More than twenty books, translated into English, Russian, Chinese and sometimes into Japanese: *Equations différentielles opérationnelles et Problèmes aux limites*, Springer-Verlag (1961); *Quasi-Réversibilité* (avec R. Lattes), Dunod (1967); *Problèmes aux limites non homogènes et Applications* (avec E. Magenes), 3 vol., Dunod, Paris (1968); *Sur le Contrôle optimal de systèmes gouvernés par des équations aux dérivées partielles*, Dunod (1968); *Quelques méthodes de résolution des problèmes aux limites non linéaires*, Dunod (1969); *Les inéquations en Mécanique et en Physique* (avec G. Duvaut), Dunod (1972); *Analyse numérique des inéquations variationnelles* (avec R. Glowinski et R. Tremolieres), 2 vol., Dunod-Bordas, Paris 1976); *Perturbations singulières dans les problèmes aux limites et en Contrôle optimal*, Springer Verlag, NY (1973); *Sur quelques questions d'Analyse, de Mécanique et de Contrôle optimal*, Presses de l'Uni. de Montréal (1976); *Applications des inéquations variationnelles en Contrôle stochastique* (avec A. Bensoussan), Dunod-Bordas, Paris (1978); *Asymptotic Analysis for Periodic Structures* (avec A. Bensoussan et G. Papanicolaou), North-Holland, Amsterdam (1978); *Some Methods in the Mathematical Analysis of Systems and their Control*, Science Press, Beijing (China) et Gordon & Breach Science Publishers Inc., New York (1981); *Contrôle impulsionnel et inéquations variationnelles* (avec A. Bensoussan), Dunod-Bordas, Collection M.M.I., Paris (1982); *Contrôle des systèmes distribués singuliers*, Gauthier Villars, Collection M.M.I., vol. *13*, Paris (1983); *Analyse mathématique et calcul numérique pour les Sciences et les Techniques* (avec R. Dautray), en 3 vol., Masson, Paris (1984-1985). Réédition en 9 volumes, Masson, Paris (1988); *Modelling, Analysis and Control of Thin Plates* (with J.E. Lagnese), Masson, Paris (1988); *Contrôlabilité exacte, Perturbations et Stabilisation de Systèmes Distribués*, Masson, Paris, Collection R.M.A. (1988), Perturbations, vol. R.M.A. *9*

(1988); *"El Planeta Tierra", El Papel de las Matematicas y de los Super Ordenadore*. Traduction: I. Diaz et M. Artola Mendez, Publication: Instituto de España, Espasa Calpe S.A., Madrid, *8* (1990); *Sentinelles pour les systèmes distribués à données incomplètes*. Masson, Paris (1992); *Models for the coupled atmosphere and ocean* (with R. Teman and S. Wang), Computational Mechanics Advances, Ed. North Holland, vol. 1 n ° 1 (1993); *Sur le contrôle parallèle des systèmes distribués* (with O. Pironneau), CRAS, Paris, t. 327, Série 1, 993-998 (1998) (dédié à la mémoire de Jean Leray); *Algorithmes parallèles pour la solution de problèmes aux limites* (with O. Pironneau), (dédié à la mémoire de Jean Leray), C.R.A.S. 327, 947-952 (1998); *Parallel decomposition of control problems for Navier-stokes equations* (with O. Pironneau) (dedicated to A. Chorin), Berkeley (1998); *Approximation of elliptic problems by decomposition methods* (with O. Pironneau). To appear (1998); *Decomposition methods and Lagrange multipliers* (with O. Pironneau) (1998); *Domain decomposition methods for CAD* (avec O. Pironneau), C.R.A.S., t. 328, Série I, 73-80 (1999); *Decomposition of energy, spaces and applications* (with A. Glowinski and O. Pironneau), C.R.A.S., Paris (1999), to appear.

Commemoration – Jacques-Louis Lions was a very bright French scientist endowed with many skills and moral qualities. He showed these on many occasions and in many responsibilities; for instance at fifteen during the war, as chairman of INRIA ('Institut National de Recherche en Informatique et Automatique'), as a President of the CNES ('Centre National d'Etudes Spatiales'), as the President of the French 'Académie des sciences' in 1997 and 1998. But above all, he was a remarkable mathematician who, I think, deserves to be recognized as the best in applied and industrial mathematics during the second half of the twentieth century. Consequently, in order to keep this notice as usual at a reasonable length, I will concentrate on a few highlights of his wonderful mathematical work. To characterize the field of his achievements, I will quote Philippe Ciarlet writing that 'it concerns partial differential equations in all their states: existence, uniqueness, regularity, control, homogenization, numerical analysis, and of course, their applications to mechanics, oceanography, meteorology'. When he was a student at the 'Ecole normale supérieure', he was already considered among his schoolmates as the most hardworking. After receiving his diploma, he was appointed by CNRS as a researcher at the Nancy group of Laurent Schwartz, who had just received in 1950 the Fields Medal for his creation of the distributions theory. Jacques-Louis Lions worked on applications of this theory to various differential equations and gained his doctorate in 1954. He immediately became professor in the mathematical department of Nancy which was at that time very famous thanks to the high standard of its professors and of its research students. From the very start, Jacques-Louis was attracted by the applications and strongly encouraged by two fellow workers of the same age: Robert Lattes, also a graduate from the Ecole normale who was later director of the SEMA ('Société d'Economie et de Mathématiques Appliquées'), and Robert Dautray, a prominent graduate from the Ecole polytechnique, who had a high responsibility in the most advanced research department of the CEA ('Centre de l'Energie Atomique'). In 1962, Jacques-Louis was elected Professor at the Sorbonne, the Sciences Faculty of Paris University. He immediately created a seminar in numerical analysis which was soon very famous and, a few years later, the 'Laboratoire d'analyse numérique' which has been one of the best departments of this discipline in Europe. In 1973 he became at the same time, Professor at the 'Collège de France' in the chair: 'Analyse numérique des systèmes et de leur contrôle' and member of the French 'Académie des sciences'. In the 'Collège', his course, new each year, as required by tradition, and the weekly seminar on 'Mathématiques Appliquées' were both followed by many people, colleagues and research students. Professor at the Ecole Polytechnique between 1966 and 1986, he created in this famous school a new course of Applied Mathematics which was highly appreciated by the students. Many of them decided to work in this field after getting their diploma. Despite all these highly time-consuming responsibilities, Jacques-Louis Lions succeeded in being a fantastic author: more than twenty books, some of them in collaboration with colleagues or students; most of them have been translated not only into English but also into many other languages. Moreover, he wrote more than five hundred papers. These figures are completely unusual in mathematics. Most of these works found a systematic presentation in a monumental treatise of four thousand pages entitled: 'Analyse mathématique et calcul numérique pour les sciences et les techniques' published in 1985 by Jacques-Louis Lions and Robert Dautray which, very often, has been rightly considered as the contemporary version of the famous Courant and Hilbert. Let us mention briefly some of the new concepts and topics he introduced and developed. Since 1954, his collaboration with Magenes, Stampacchia, de Giorgi and Prodi gave rise to a three-volume treatise entitled Problèmes aux limites non homogènes. A little later, he became interested in problems of mechanics and physics, and in 1972 with Georges Duvaut, he published Les inéquations en mécanique et en physique. This book showed how fruitful were the functional methods for solving difficult problems arising from Bingham fluids, viscoelasticity, plasticity. So far, the numerical solutions were obtained by methods of 'finite differences'. They were not easily applicable to many situations, for instance in a domain of complex geometry. Lions brought his attention to new methods, introduced by engineers, called 'finite elements methods'. With his coworkers, he succeeded in giving to these methods a highly satisfactory mathematical presentation. It can be found in the book Calcul numérique des solutions des inéquations en mathématiques et en physique written with Roland Glowinski and Raymond Trémolières. One must also mention the book Quelques méthodes de résolution de problèmes aux limites non linéaires in which Lions introduced systematically the methods of

compacity, of monotony, of regularisation, of penalisation which are essential tools for studying for instance Navier-Stokes equations, von Karman equations, Schrödinger equation, Korteweg de Vies equation. Many useful theories in Mechanics investigate the properties of solutions when some parameters remain small: they lead to what may be called ‘asymptotic analysis of these problems’. Methods were introduced: boundary layer theory, singular perturbation, multiple scales, homogenization. Again, Lions wrote a mathematically satisfactory presentation in at least two books. It would be important to report on all the works and books dealing with control theory, a field to which Lions gave special attention right up to his death and in which his contributions are of fundamental importance. Even if I cannot do it here, I hope that what has been said above proves how exceptional was this mathematician. He was a genius who has often been compared to Henri Poincaré or to John von Neumann.

Paul Germain