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- Author: Margherita Barile
- Affiliation: University of Bari "Aldo Moro", Italy
- e-mail address: margherita.barile@uniba.it

Jacques-Louis Lions

Ex Officio Member of the Executive Committee 1975-1982, 1991-1994

Margherita Barile



1 Short biography

Jacques-Louis Lions was born in Grasse, in the district of Alpes-Maritimes, in southeastern France, on 3 May 1928. There he attended primary and secondary school. In 1943, at the young age of 15, he joined the *Forces Françaises de l'Intérieur*, where he served as a resistent to the German occupation for about one year. In 1946 he left his beloved hometown to study at the *Lycée Félix-Faure* of Nice, and in 1947 he entered the *École Normale Supérieure* of Paris. He obtained the doctorate in 1954 at the University of Nancy, where he had studied with a grant from the *Centre National de la Recherche Scientifique*. His dissertation, entitled “Problèmes aux limites en théorie des distributions”, prepared under the supervision of Fields Medallist Laurent Schwartz, was published in *Acta Mathematica*. In the same year he was appointed professor. He remained in Nancy until 1962; then he moved to Paris, where he taught numerical analysis at the Faculty of Science of the University of Paris (later, at the *Université Paris VI “Pierre et Marie Curie”*) until 1973. There he also initiated a weekly seminar at the *Institut Blaise Pascal*, created a post-graduate diploma in numerical analysis and set up a laboratory that still bears his name. At the same time, he was a part-time professor at the *École Polytechnique* from 1966 to 1986, the year when he was appointed honorary professor. In 1973 he was named by the *Collège de France* to the Chair of “Mathematical Analysis of Systems and their Control”, which he retained until 1998, when he retired and received professor emeritus status. In 1973 he was also elected to the *Académie des Sciences*, where he was to become vice-president in 1995 and then president in the term 1996-1998. He held high-level managing and counselling positions in several scientific organizations, governmental institutions and industrial companies, among which: the

Société d'Économie et de Mathématiques Appliquées (from 1958 on), the *Institut National de Recherche en Informatique et en Automatique (INRIA)* (1980-1984) of which he founded the main centre in Paris, and later the new sites at Nice-Sophia Antipolis and Rennes, the *Ministère de l'Industrie et de la Recherche* (1983-84), the *Centre National d'Études Spatiales (CNES)* (1984-1992), the *Conseil Scientifique d'Électricité de France* (1986-1996), the *Comité Scientifique de la Météorologie Nationale* (1990-2001), the *Conseil Scientifique de Gaz de France* (1993), and the *Conseil Scientifique de France Télécom* (1998-2001). He was President of the International Mathematical Union from 1991 to 1994, and in this capacity he proclaimed, at the *Instituto de Matemática Pura e Aplicada* of Rio de Janeiro, on 6 May 1992, the year 2000 as the World Mathematical Year (WMY). This year should also be recalled as the one where, during an official ceremony at the Elysée Palace, with the members of the *Académie des Sciences* as invited guests, Lions handed to President Jacques Chirac, as the result of a three-year teamwork, a detailed report on the most recent scientific achievements concerning the following socially relevant issues: “access to knowledge for all and electronic processing of information; knowledge of our planet and ways of life; understanding life systems and improving health care of all.”

The most remarkable feature of Lions' scientific profile is, indeed, the great effort towards theoretical progress combined with a great interest in applications in economics and finance, management, engineering, energy production, meteorology, environmental problems, and life sciences in general.

Following the original approach of Laurent Schwartz, based on distributions, Lions succeeded in enhancing the study of partial differential equations in a ground-breaking way, not only improving its understanding in the context of variational and quasi-variational calculus, but also investigating its connections with interdisciplinary areas such as optimisation problems, fluid dynamics, electro-magnetism, material physics. During the sixties, his activity became more and more focused on deterministic and stochastic system control: this was the subject of his inaugural lecture held at the *Collège de France* on 4 December 1973.

Working in this direction, he strongly endorsed the use of computer-based numerical techniques and the implementation of symbolic algorithms, for the elaboration of models to be verified by experimental results. He considered an efficient collection and completion of data as the crucial starting point towards a better knowledge of the physical phenomena, a goal that could be pursued both from the mathematical point of view (see the concept of "sentinels" for the control and detection of pollution introduced and studied in one of his books on control, 1988) and from the technological side (see his contribution to the French-American satellite *TOPEX/Poséidon*, 1992). Approximation should step in where exactness was out of reach, as in non-linear problems, a global view should make up for the insufficiency of local observations, and reality should be regarded as a network of interrelated subsystems, such as the coupled atmosphere and ocean, or *the Mediterranean region, the monsoon, El Niño, cloud physics* (Lions 1992, p. 13): mastering such a complexity was a *visionary's*¹ dream, that the emerging powerful ICT tools were making come true. Lions expressed this firm conviction when, in his invited conference on 28 January 1998 at the *Real Academia de Ciencias* in Madrid, he thoroughly described the background of the Japanese project of an “Earth Simulation” (Lions 1998). In his balanced, comprehensive view of scientific progress, the machines should not be called to replace the researcher's mind, but be employed as a source of motivation and enrichment. Their historical role in the problems of *understanding, predicting, designing* and *managing* the behaviour of systems is best outlined by Lions' own illuminating overview:

For these questions, a 'divine help' ('help' is different from 'solution') came from the computer. The Universal machine of A. Turing (1937) became 'real' (and not only 'virtual'). The 'inextricable' computations (in the D'Alembert words) for Euler equations became possibly accessible. The 'dream' of L.F. Richardson (1910-1920) for weather prediction could be envisioned. This was indeed the J. von Neumann program stated in the period 1948-1950.²

¹ See Ciarlet 2002, p. 284. The same word appears in (Yoccoz 2001, p. 3)

² This is the closing paragraph in the abstract of Lions' talk *From function spaces to action*, held in Brussels, at the *Symposium de la Fondation Jacques et Yvonne Ochs-Lefebvre "Reflections on XXth century sciences"*, on 16 April 1999. See pp. 41-42 of the document available at

The underlying idea of what Lions called the *universal trilogy*, formed by *modelling, simulation and system control*, would be further developed in his public address at the Spanish *Congreso de los Diputados* (21 January 2000). His answer to the question posed in the title (*Is it possible to describe the nonliving and the living world in the languages of mathematics and computer science?*³) presents the scientific and cultural achievements of the past as the natural foundations of the ongoing technological advances.

Lions wrote around 500 scientific papers and authored or edited nearly 60 expository books, among which the nine volumes of the monumental treatise "*Analyse mathématique et calcul numérique pour les sciences et les techniques*" (1984-1985), written with Robert Dautray, which is considered as his masterpiece and lifework.

Lions is nowadays regarded as the father of applied mathematics in France. At a time when, in his country, the structural approach of the Bourbaki group was the predominant trend, he had the sagacity and braveness of moving against the tide, and search for interactions with the real world.

Lions collected a huge number of prestigious international awards. Degrees *honoris causa* were bestowed on him by nineteen universities from the whole world. Moreover, he won the *Prix Cognacq-Jay* (1972), the *John Von Neumann Prize* (1986), the *Japan Prize in Applied Mathematics* (1991), the *Harvey Prize* from *Technion*, Haïfa, Israel (1991), the *Daedalon Gold Medal for Science and Technology* from Greece (1991) and the *W.T. and Idalia Reid Prize* of the *Society for Industrial and Applied Mathematics* (1998), the *Lagrange Prize* of the *International Council for Industrial and Applied Mathematics* (1999), the *Hilbert Medal* of the *International Conference on Computational & Experimental Engineering and Sciences* (2000).

He also received the following decorations: *Commandeur de la Légion d'Honneur* (1993), *Grand Officier dans l'Ordre National du Mérite* (1998), from France, and the *Order of the Rising Sun, Gold and Silver Star* (1998) from Japan.

As a result of the international character of his research activity, he became member of over twenty foreign academies. His innumerable scientific visits abroad left a lasting mark, e.g. in Italy, Spain and in the former Soviet Union: the Russian Gury Marchuk and Lev Pontryagin were, together with Lions and the Indo-American Alampallam Venkatachalaier Balakrishnan, the co-founders of the journal *Applied Mathematics & Optimization*. Lions is also credited with being the initiator of the joint French-Russian manned space missions *Soyouz* in 1982 and 1992. One of Lions' most remarkable merits are his organizing activities in developing countries; he played a major role in the creation of an "applied" branch of the *Tata Institute* in Bangalore (India), of the *Laboratoire Franco-Chinois d'Informatique, d'Automatique et de Mathématiques Appliquées* in Beijing, and of the *Institut Sino-Français de Mathématiques Appliquées* in Shanghai and thoroughly supported the *Third World Academy of Sciences* in its promotion of mathematical research in Africa.

Lions was an influential personality, whose outstanding professional and moral qualities earned him worldwide recognition. The former French minister and president of the *European Space Agency* Hubert Curien thus explains the reasons of his success: "He was not a man of diktat, but of contact, discussion and decision." (Bermúdez de Castro et al., p. 355)

The French *Société de Mathématiques Appliquées et Industrielles*, in collaboration with INRIA and CNES, has created the annual *Prix Jacques-Louis Lions*, which was awarded for the first time in 2003, to Roger M. Temam.

Jacques-Louis Lions died in Paris on 17 May 2001.

2 Contributions to education

A relevant part of Lions' mission was raising awareness of mathematics, at any level, and everywhere. In the framework of the activities of general interest planned for WMY 2000, he chaired the scientific committee of the conference *Mathematics and its role in civilization* (11-14 January 2000). The meeting took place in Macau, soon after its reincorporation into China. The program was centred on interdisciplinary, historical and multicultural aspects. His Chinese student Li Tatsien (Li Daqian) points

<http://www.academieroyale.be/Academie/documents/OchsReflections13648.pdf>

³ Lions 2000. For an extended, detailed presentation of the topic see the monograph (Lions 1990).

out that the initiative “added a piece of bright landscape for new-returned Macao.” (Tatsien 2004, p. 23)

Lions’ versatile, far-reaching gifts and his intensive engagement for the innovation of mathematics as a lively component of modernity earned him not only worldwide fame, but also the devoted admiration of his colleagues and students (at least 46, with a total of over 3,300 descendants, spread over six scientific generations). Enrico Magenes, with whom Lions coauthored a three-volume book on nonhomogeneous boundary value problems between 1968 and 1970, says:

I had the opportunity to fully appreciate the intellectual and human qualities of Lions: his unaffected manners; his commitment and energy in work; his rapidity of intuition and decision; his openness to new ideas and new problems in a body of knowledge that increased more and more over time, even outside mathematics; his love of freedom; and his respect for the opinions of others. (Lax et al. 2002, p. 1321)

According to Peter D. Lax, “Lions had an open, friendly, generous personality, with a light touch and a subtle sense of humour.” (ibid., p. 1320)

Lions’ collaborator Roland Glowinski also mentions his *sense of essentiality* along with his *inborn sense of theater*, which made his lectures and written works so attractive to a broad audience. All his presentations were “remarkable for their clarity, their style, their conciseness and their organization.” (Glowinski 2003 pp. 2-4)

And these are the words of gratitude expressed by Lions’ student Roger M. Temam in his commemorative article (Temam 2001):

All his students were delighted and amazed at his quick reading of their drafts, and at his availability to each of them. Also a factor in his success as an adviser was his ability to determine very quickly which research would suit a new student, and then to tailor new problems to the student’s abilities. Always careful not to influence his students too much, he described himself as a counsellor, striving to help each student develop the best of his/her possibilities. ... Jacques-Louis Lions was an exceptional person in many respects. Charismatic, generous, open, and accessible, he avoided conflict whenever possible. Among the most striking aspects of his personality was his long-term vision; he was able to see and pursue ideas that would come to maturity only five, ten, or twenty years later. He had many good ideas, and he had the mathematical talent, the physical strength, and the understanding of people needed to implement them.

In a written multivoiced testimony from Lions’ numerous visits to Spain, Enrique Fernández Cara recalls his *farsightedness* and *optimism*, which enabled him to overcome contentious situations and simplify difficult tasks (Bermúdez de Castro et al., p. 361). Nevertheless, he “would claim that he was learning from his students”, as Pierre Bernhard reports in his editorial (Bernhard 2002, p. 570). As an evidence of Lions’ expectant, confident attitude towards his auditory, Magenes (Magenes 2001, p. 193) reports how his written and oral presentations always ended with the statement of some unsolved problems.

These personal memories, together with the extraordinary talent he passed on to his son Pierre-Louis (who won the Fields Medal in 1994), are Jacques-Louis Lions’ invaluable human legacy.

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