

IN MEMORIAM

## Professor Isao Imai, 1914–2004

To cite this article: Hidenori Hasimoto 2007 *Fluid Dyn. Res.* **39** 1

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Fluid Dynamics Research 39 (2007) 1–4

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In Memoriam  
Professor Isao Imai, 1914–2004



Professor Isao Imai, Academician of the Japan Academy, a person of cultural merits passed away on October 24, 2004 at the age of 90. It is our deepest grief that we cannot see this great and beloved scholar and scientist again. He was a former honorary editor of our journal.

Professor Imai was born on October 7, 1914 in Dairen, Manchuria (now Lüda, China), and a few years later his family returned to Kobe where he spent his childhood. His talent was already so outstanding in his early days that he skipped one grade in elementary school and another in middle school, and he entered the First High School (now, the College of General Education, the University of Tokyo) which was one of the most difficult gates through which to pass. Then, he proceeded to the Tokyo Imperial University (now, the University of Tokyo), majoring in physics, graduated at the age of 21, two years younger than most of the students of that time. Upon his graduation in March, 1936, he was appointed assistant to Professor Susumu Tomotika in the newly established Imperial University of Osaka (now, Osaka University). Two years later, in 1938, he returned to the University of Tokyo as a lecturer, and

in 1942 was promoted to assistant professor. From 1950, he was professor of physics in the Faculty of Science until his official retirement from the University of Tokyo on April 1, 1975. He was concurrently a member of the Aeronautical Research Institute, the University of Tokyo (1938–1964). He was also visiting professor at a number of overseas universities, the University of Maryland, U.S.A. (1955–1957), the University of Marseille, France (1960), D.V.L. Aachen, West Germany (1961–1962), Cornell University, U.S.A. (1965–1966, 1977), and the Technical University of Aachen (1969). On his retirement from the University of Tokyo, he became Professor Emeritus of the same university and moved to Osaka University as professor of mechanical engineering in the Faculty of Engineering Science (1975–1978) and then to Kogakuin University (1978–1987) where he got the title of Professor Emeritus. Since 1994 he was an Academician of the Japan Academy.

Professor Imai's first interest in fluid mechanics seems to have been evoked by Professor Terazawa in Tokyo and Professor Tomotika in Osaka, both being the pioneers of modern fluid mechanics in Japan. His first collaborative book on aerodynamics (1940) was written on the basis of Professor Terazawa's lecture. His first paper on the stability of the Kármán vortex street in a channel, which appeared in the *Comptes Rendus* (Paris, 1936), dealt with a generalization of Professor Tomotika's work. A great deal of elaborate work on the effects of boundaries on two-dimensional flow past an aerofoil was also carried out by Professor Imai in close collaboration with Professor Tomotika. Then, the attention of Professor Imai turned toward the compressible flow problems stimulated by the impact of the age of high-speed flight. His first paper in this field was concerned with compressible flow past a circular cylinder, wherein he corrected the errors of previous theories. This paper was cited by von Kármán in his famous Gibbs Lecture entitled "The Engineer Grapples with Nonlinear Problems" with the comment, "The calculations of the Japanese authors are the most reliable ones." Since then, he has presented a variety of new methods, now known by his name, for dealing with high-speed flow problems. His theories of arbitrary wing sections and of transonic flow based on the WKB method are representative of his work during this period. Most of this work was accomplished before the end of World War II and was scarcely known outside of this country, although later on they came to receive worldwide recognition. In 1951, he received the Asahi Prize from the *Asahi Shinbun* (newspaper), and in 1959 was awarded the Imperial Prize from the Japan Academy in recognition of his great contribution to aerodynamics. In 1962, he was elected a fellow of the Institute of Aeronautical Sciences (now, American Institute of Aeronautics and Astronautics), U.S.A.

During the period just after World War II, when aeronautical research was prohibited in Japan, Professor Imai's interests were directed to broader areas in mathematical physics. He carried out a refinement of the WKB method for differential equations having turning points, and the Imai formula has been used successfully in many problems including heat transfer and wave diffraction theories by himself. His attention was also directed to the basic and difficult problems of viscous flow. He resolved the paradoxes of Filon and Goldstein concerning the moment of a cylinder moving in a viscous fluid and the structure of the wake behind the cylinder. In dealing with the slow motion of a viscous fluid, he presented a new general method for dealing with two-dimensional flow at small Reynolds numbers as well as a new general solution of the Stokes equation for the three-dimensional flow. For flow at large Reynolds numbers he proposed a theory of flow around bluff bodies and presented, for the first time, the proper correction term to Blasius' solution of the boundary-layer problem on a semi-infinite flat plate. When the study of magneto-hydrodynamics began to develop in the late fifties, he played a leading role, presenting many elegant theories based on his former achievements in ordinary fluid mechanics. By introducing the concept of a hypothetical gas, he reduced the magneto-hydrodynamical flow problem of a perfectly conducting fluid in an aligned magnetic field to that of an ordinary fluid. He also applied the method of conformal

mapping to the problem of plasma confinement. This is only representative of his works in this field, heralding a new epoch in magneto-hydrodynamical research in Japan.

The scientific work of Professor Imai has been published in more than 80 papers and 10 books, which contain many previously, unpublished results. Every one of these papers and books bears the hallmark of his work, an elegance of mathematical analysis and a completeness of theoretical treatment. His activity did not cease and became even wider in scope until the last year, struggling against a cancer of the lower jaw. He has become interested in the interpretation of conformal mapping as well as hyperfunctions in terms of fluid mechanics. Rewriting of mechanics and electromagnetism was made on a general theory of momentum flow and lines of force. The translation of books on these works published recently in Japanese is eagerly expected. It may be noted that the English translation *Applied hyperfunction theory* (Kluwer Academic Publishers, 1992) is getting popular among worldwide researchers and students.

The great reputation of Professor Imai for his scientific ability, as well as his warm personality and broad-mindedness have caused him to be called upon to take high administrative responsibilities in several academic institutions. At the University of Tokyo, he served as the director of the University Library (1972–1975). He has been one of the most important members of the Physical Society of Japan, serving twice as the President (1959–1960, 1963–1964) and then was the Vice-president of the International Union of Pure and Applied Physics (IUPAP 1978–1984). He was the chairman of the National Committee for Physics as well as the National Committee for Theoretical and Applied Mechanics and was a Bureau member of the International Union of Theoretical and Applied Mechanics (IUTAM 1984–1992). He served as the chairman of the National Organizing Committee of two IUTAM Symposia i.e. Symposium on Ionized Gases (1971) and Symposium on Fundamental Aspect of Vortex Motion (1987) both held in Tokyo. He was nominated an honorary member of the Japan Society of Aeronautics and Astronautics, the Japan Society of Fluid Mechanics and the Visualization Society of Japan. He has been a Member of the Japan Academy since 1994, and a person of cultural merits since 1979. He was awarded a Cultural Medal in 1988 and the First Class Order of the sacred treasure in 1992.

The talent of Professor Imai is by no means limited to the field of natural science. It is well known that he is a linguist having a special interest in Japanese grammar. His theory on the basic structure of Japanese sentences, which is entirely different from those of Indo-European languages, was published both in Japanese and English. He was a regular member of the Logergists, a famous group of physicist–essayists who are interested in talking about all subjects in nature and daily life from the cool but humorous viewpoints of physicists (the name Logergist was taken from the Greek words *logos* (information) and *ergon* (work, energy)). The essays of this group were welcomed by eager readers and got popular among intellectual people.

I still remember the old days of 60 years ago when I was a sophomore student and he was a young assistant professor. Owing to the bad situations after the defeat in the war he was at first reluctant in accepting students in his group. We were hungry in all respects. We were obliged to look for available literatures in place of scarce provisions. Among the readings in our seminars I remember *The Theory of Solids* by Seitz and *The Introduction to Chemical Physics* by Slater et al. The publication of the works on the WKB method and Filon's paradox belongs to this period. These were related to his interest in the nonlinear electromagnetism of Born–Infeld as well as the Quantum field theory. The enlargement of our group after his acceptance of the Asahi prize was interrupted by his invitation to the U.S.A. in 1955. We were in fear of his permanent stay there and were relieved by his return in 1957. Regular and special lectures of Professor Imai delivered at the University of Tokyo and other universities, both local and foreign, are famous for their clarity of logic and the simplicity of exposition, and therefore attract

numerous eager audiences. Anyone who has ever had the opportunity to see and talk with him is impressed by his nice warm-hearted personality and receives inspiration and encouragement from his words based upon a thorough insight into the subject and a rich background of knowledge.

After sixty years of grace on us he does not come back again. It is a regret that we could not hear his last will to us because of his sudden death. It is our duty to banish this sorrow and transfer his ambition analytically to the next generations to come, standing on the firm work accomplished by this great professor, Imai *Sensei*.

### **Further reading**

Hafez, M., 2004. Dedication to Professor Emeritus Isao Imai (containing Imai's lecture memos given at Lake Tahoe meeting of ASME in 1994: Teaching Fluid Dynamics-Personal Recollections), *Comput. Fluid Dyn. J.* 13, 365–376.

Hasimoto, H., Tatsumi, T., 1975. Preface. *Studies in Fluid Mechanics and Applied Mathematics*, Professor Isao Imai 60th anniversary volume, i–iii.

Oshima, K., 2004. Dedication to Professor Isao Imai by an aerospace engineer. *Comput. Fluid Dyn. J.* 13, 377–382.

Hidenori Hasimoto  
*Emeritus Professor of the University of Tokyo*  
*E-mail address: [hasi.eiten@nifty.com](mailto:hasi.eiten@nifty.com)*