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with the assistance of AMS staff

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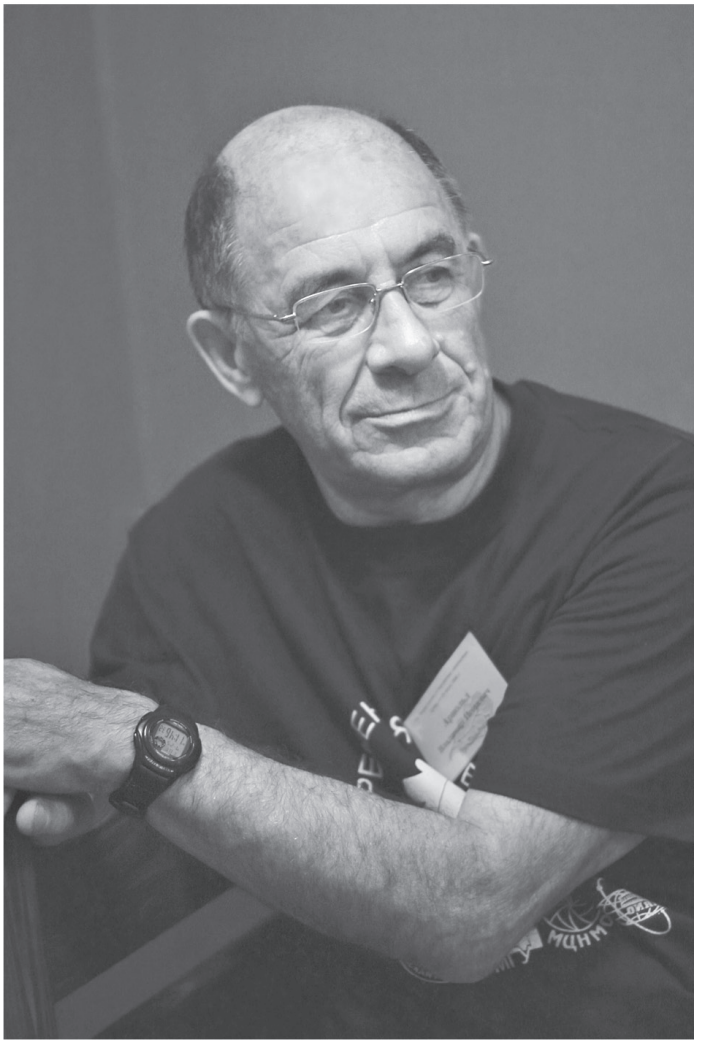

Vladimir Igorevich Arnold
(12 June 1937 – 3 June 2010)

VLADIMIR IGOREVICH ARNOLD

The President of the Moscow Mathematical Society, an outstanding mathematician of the present, Vladimir Igorevich Arnold unexpectedly passed away on June 3, 2010 in Paris several days before his 73rd birthday. This is a bereavement not only for his relatives, friends and students, but for the whole mathematical and more generally scientific community. Vladimir Igorevich was one of few mathematicians who formed the face of mathematics in the second half of the 20th century.

V. I. Arnold was born on June 12, 1937 in Odessa, USSR. As Vladimir Igorevich told, the name Arnold (initially Arnoldi) had been brought to Russia by a German officer, who came to serve in Russia several centuries ago. The father of Vladimir Igorevich, Igor Vladimirovich Arnold (1900–1948) was a mathematician, a corresponding member of the Academy of Pedagogical Sciences of the Russian Soviet Federative Socialist Republic. His mother Nina Alexandrovna Arnold, born Isakovich (1909–1986), was an art historian and worked at the Pushkin Museum of Fine Arts in Moscow. V. I. Arnold graduated from Moscow high school no. 59, which produced a number of members of the Russian Academy of Sciences. From 1954 till 1959 he was a student at the Faculty of Mechanics and Mathematics of the Moscow State University. On his third year at the university, V. I. Arnold together with his teacher A. N. Kolmogorov found a negative solution for the 13th Hilbert problem by showing that the solution of a general algebraic equation of degree seven can be represented as the superposition of continuous functions of two variables. This result made his Ph.D. thesis, defended in 1961 at the Moscow Keldysh Institute of Applied Mathematics. During the defense, an opinion was expressed that the presented results deserved the awarding of the Doctor of Sciences degree (the highest scientific degree in Russia). However, A. N. Kolmogorov suggested to not requalify the Ph.D. thesis, since its author was able to prepare a Doctor of Sciences thesis in shortest time. V. I. Arnold defended the Doctor of Sciences thesis at the same Institute in 1963. The thesis was titled "Problems of stability in the classical and celestial mechanics" and contained results which became a part of the celebrated KAM theory named after its creators: Kolmogorov, Arnold, and Moser. KAM theory states that under weak perturbations of an integrable Hamiltonian system, some of the invariant tori are deformed and survive, while others are destroyed. A number of two hundred year old problems were solved with the help of KAM theory.

V. I. Arnold is widely known as one of the creators of singularity theory: a theory with numerous applications, in particular in differential and algebraic geometry, differential equations, bifurcation theory, Hamiltonian mechanics, optics, etc.

It is impossible even briefly to list here all the mathematical achievements of V. I. Arnold. His name appears in many notions of dynamical systems theory: the Liouville-Arnold theorem, Arnold's tongue, Arnold's diffusion, Arnold's cat (also called Arnold's okroshka: the name of a Russian cold soup based on a Russian drink "kvas"), etc. Symplectic topology emerged from Arnold's conjecture on the number of fixed points of a

symplectomorphism formulated in the mid 1960s. Modern revitalization of real algebraic geometry was connected with the work of V. I. Arnold on arrangements of ovals of a real plane algebraic curve (1971). The work on the cohomology of the pure braid group (1968) was one of the starting points of the modern theory of hyperplane arrangements. V. I. Arnold's works on the classification of critical points of functions led, in particular, to the Newton polyhedra theory. Arnold's strange duality for 14 exceptional unimodal singularities was one of the first examples of the mirror symmetry phenomenon.

V. I. Arnold did not separate mathematics from natural sciences: "Mathematics is a part of physics. Physics is an experimental science, a part of the natural sciences. Mathematics is the part of physics where experiments are cheap."

V. I. Arnold has published more than 500 papers and almost 50 books. His "Mathematical Methods of Classical Mechanics" and "Ordinary Differential Equations" became classical university textbooks.

V. I. Arnold held positions at Moscow State University from 1961 till 1986, Steklov Mathematical Institute in Moscow since 1986, University Paris–9 (Paris-Dauphine) from 1993 till 2004.

V. I. Arnold was one of the creators of the Independent University of Moscow and one of its first professors; he gave several courses there. For almost 14 years, Vladimir Igorevich was President of the Moscow Mathematical Society.

V. I. Arnold had high authority in the international mathematical community and influenced its life. He was a vice president of the International Mathematical Union from 1995 till 1998, a member of its Executive Committee from 1999 till 2002.

For a long time V. I. Arnold was Editor-in-Chief of the journal *Funktsionalnyi Analiz i ego Prilozhenia* (Functional Analysis and its Applications), founded in 1967 by another great mathematician of the 20th century, I. M. Gelfand. It is interesting to note that the first issue of the first volume of *Functional Analysis* started with the celebrated paper by V. I. Arnold "On a characteristic class entering into conditions of quantization." Several years ago V. I. Arnold had founded a new international mathematical journal *Functional Analysis and Other Mathematics*. He was a member of the editorial boards of numerous mathematical journals, in particular, of *Uspakhi Matematicheskikh Nauk* (Russian Mathematical Surveys), *Izvestiya Akademii Nauk* (Izvestiya Mathematics), Inventiones Mathematicae, Journal of Algebraic Geometry, Selecta Mathematica, Moscow Mathematical Journal, Journal of Geometry and Physics, Bulletin des Sciences Mathématiques, etc.

V. I. Arnold had been the recipient of a number of Soviet, Russian, and International awards, such as the Award of the Moscow Mathematical Society (1958), the Lenin Prize (1965, with Andrei Kolmogorov), the Crafoord Prize (1982, with Louis Nirenberg), the Wolf Prize in Mathematics (2001), the State Prize of the Russian Federation (2007), the Shaw Prize in mathematical sciences (2008, with Ludwig Faddeev). V. I. Arnold was a foreign member of a number of academies and Doctor Honoris Causa of several universities. In 1981 the minor planet 10031 Vladarnolda was named after him.

V. I. Arnold had strong opinions on many subjects. He was an ardent fighter against formal axiomatic Bourbaki style exposition in mathematics. In connection with this he participated in a public duel with J.-P. Serre (finished with each keeping his own opinion).

V. I. Arnold was critical of modern emasculation of mathematical education in Russia and in the world. His ideas on teaching students were reflected in the papers "Mathematical trivium" and "Mathematical trivium – II" (published in *Russian Mathematical Surveys* in 1991 and 1993). V. I. Arnold wrote that the knowledge of students should be determined not by the courses they have followed, but by problems they are able to solve. He offered a list of 100 problems that graduates of departments of mathematics

have to be able to solve. In 2004, V. I. Arnold wrote a book "Problems for children from 5 to 15."

V. I. Arnold was a leader surrounded by students and colleagues. The list of his "direct" students includes nearly 50 names. His lectures attracted crowds of people. Every semester V. I. Arnold started his seminar at Mekh-Mat (Department of Mechanics and Mathematics) with a new list of problems. Very often those problems became topics of research of seminar members. The problems were collected and published later in a 600 page book "Arnold's Problems."

V. I. Arnold was interested in the history of science, read original works of the classics: Euler, Newton, Poincaré, etc., was a co-editor of the translation into Russian of "Selected Works" of Poincaré. He wrote a remarkable book "Huygens and Barrow, Newton and Hooke."

Arnold thought that vigorous occupation with mathematics should be accompanied by vigorous physical exercises. He skied regularly in winter (about 100 km per week), and in summer rode a bicycle and took long walks on foot. Every year at the end of winter Arnold's seminar went to ski in the outskirts of Moscow. The daily distance was about 50 km. Usually the skiing was complemented by bathing in the streambed of a small river which was not frozen even in winter. The tradition of bathing in any open water at any time of the year Arnold had adopted from his teacher Kolmogorov. This tradition was taken up by many participants of the seminar.

V. I. Arnold was interested in many things outside mathematics. He knew history and poetry and liked to tell stories on people of different times from Ancient Egypt to our days. Some of the stories were collected in the book "Yesterday and Long Ago." It is regretful that the majority of these stories were not written down and seem to be lost by now.

Vladimir Igorevich has left us his works, books, problems, students. His influence will last for many, many years to come.

S. M. Gusein-Zade,
A. N. Varchenko

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