PACS number: 01.60. + q

Mikhail Izrailevich Rabinovich (on his 80th birthday)

DOI: https://doi.org/10.3367/UFNe.2021.03.038954

April 20, 2021 was the 80th birthday of Mikhail Izrailevich Rabinovich, professor, doctor of phys.-math. sciences, an outstanding theoretical physicist, and a corresponding member of the Russian Academy of Sciences (RAS).

M I Rabinovich was born on 20 April 1941 in Nizhny Novgorod into the family of the well-known chemist Izrail Beniaminovich Rabinovich. M I Rabinovich (or MIR, as his disciples and friends call him) belongs to the third generation of the renowned scientific school for nonlinear oscillations and waves founded by Academician A A Andronov and based at Gorky State University (GSU). In 1962, immediately after he graduated from the Radiophysical Faculty of GSU, he began teaching at the Department of Theory of Oscillations. In 1967, Mikhail Izrailevich defended his Ph.D. thesis, "Self-oscillations of distributed systems," under the guidance of A A Andronov's disciple A V Gaponov-Grekhov. In this thesis and in later studies (included in his D.Sc. thesis, which he defended in 1974 at the age of 33 in the 'star' council of the Institute for Physical Problems), M I Rabinovich laid the basis of a new direction in nonlinear dynamics-selfoscillating and autowave processes in distributed nonlinear nonequilibrium media. Solving problems from very different areas of physics and related sciences (nonlinear optics, plasma physics, hydrodynamics, biology, etc), M I Rabinovich continues to apply the theoretical oscillatory approach rooted in the classical work of A A Andronov. The asymptotical method for nonlinear distributed systems, developed by M I Rabinovich in collaboration with A A Rozenblum, belongs to the standard set of tools of nonlinear dynamics and theoretical physics. Many phenomena and effects discovered and investigated by him, namely, stationary autowaves, explosive instability, competition of modes, and localized autowave excitations, were later discovered or experimentally realized. Because of the Iron Curtain that separated the Soviet Union from the rest of the world till the late 1980s, many of M I Rabinovich's discoveries (for instance, stochastic synchronization) were not known abroad and were rediscovered later on.

In spring of 1972, in a guest house on the bank of the river Oka, M I Rabinovich took an active part in the organization of the Gorky school for nonlinear waves (NWs)—the first in a line of such schools that were almost continuously held every two years and are being carried out to the present day (the 19th NW school took place in spring of 2020). These schools soon became famous all over Russia and attracted very prominent Russian physicists and mathematicians as lecturers, for example, V I Arnold, E P Velikhov, A M Zhabotinskii, Ya B Zel'dovich, B B Kadomtsev, O A Ladyzhenskaya, S P Novikov, S M Rytov, R Z Sagdeev, R V Khokhlov, B V Chirikov, and many others. For many years, M I Rabinovich remained an irreplaceable organizer and a linchpin

Uspekhi Fizicheskikh Nauk **191** (4) 447–448 (2021) Translated by M V Tsaplina



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of these fortnight schools, famous not only for the highest scientific level, but also for the unique atmosphere of informal communication, high spirits, and sports. Not only was M I Rabinovich one of the brightest lecturers, but he also made great efforts to edit the school proceedings,¹ by which one can readily follow the development of nonlinear physics in its 'golden years'.

When the Institute of Applied Physics (IAP) of the USSR Academy of Sciences (AS) was founded in 1977, M I Rabinovich became head of the Sector of Nonlinear Dynamics, where he had fruitfully combined scientific and organizational work for over 15 years. This transformation coincided with the beginning of studies on the chaos theory, and M I Rabinovich is deservedly considered to be one of the pioneers in this area. Widely known are the 'Rabinovich system' and 'Rabinovich–Fabrikant system', an electron

¹ The archive of all the NW school proceedings can be found at http:// nonlinearwaves.sci-nnov.ru/publications_history.html.

generator of chaotic oscillations and investigations of chaotic solitons and irregular structures in nonequilibrium media, as well as his work on chaotic system synchronization.

A great role in the development of this discipline in the USSR was played by the review,² "Stochastic selfoscillations and turbulence" published in 1978 in the journal *Uspekhi Fizicheskikh Nauk (UFN) (Usp. Fiz. Nauk*, vol. 125, p. 123; *Sov. Phys. Usp.*, vol. 21, p. 443) and the chapter "Turbulence" in the third edition of the 6th volume of the Landau–Lifshitz theoretical physics course, *Hydrodynamics*, written together with Academician E M Lifshitz. Along with deterministic chaos, Mikhail Izrailevich Rabinovich was actively engaged in the turbulence theory, especially the behavior of coherent structures in turbulent flows, and also in pattern formation in nonlinear nonequilibrium media.

In parallel with his work at IAP of the USSR Academy of Sciences, M I Rabinovich remained professor in the Department of the Theory of Oscillations of the Radiophysical Faculty of Gorky State University and perennially delivered the lecture course on oscillations and waves. For many years, this course was considered by students to be the most interesting and intriguing one and played an important role in the choice of scientific carrier of many future scientists now working all over the world. His lectures laid the basis of the wonderful textbook, Introduction to the theory of oscillations and waves (which he wrote in co-authorship with his colleague and friend D I Trubetskov), used by several generations of specialists in nonlinear dynamics. The first edition (1984) immediately became a bibliographic rarity; the second edition appeared in 2000, and Kluwer Publishers published the English translation of this book, called Oscillations and Waves in Linear and Nonlinear Systems, in 1989.

In the late 1980s, when the Iron Curtain began to be lifted, M I Rabinovich could for the first time meet his foreign colleagues, who had known him before by his publications only. Mikhail Izrailevich recalls how he came for the first time to Houston (USA) to the annual "Dynamic Days" conference on nonlinear dynamics, got lost, and was late for the opening. The main organizer of Dynamic Days, Bob Helleman, who chaired the session, saw him and said: "Here comes Professor Rabinovich, for whom we have waited 10 years and 45 minutes."

M I Rabinovich quickly established connections in leading scientific centers around the world. In the mid-1990s, he was invited to work at the Institute for Nonlinear Science of the University of California (San Diego, USA), where he soon headed studies on nonlinear dynamic properties of neuron systems. In close cooperation with biologists and mathematicians, he began with analyses of collective oscillations, chaos, and synchronization in comparatively small systems consisting of several neurons, the so-called central rhythm generators, and then gradually moved on to space-time dynamics of large neural nets and the entire cerebral cortex. Two interconnected key ideas running through this large series of studies are competitive winnerless dynamics and their mathematical image, a stable heteroclinic channel that attracts trajectories in the system's phase space and then sends them along a certain sequence of saddle points characterizing discrete states of the nervous system.

Such a physico-mathematical model turned out to be applicable to the properties of the olfactory system of locusts and to human cognitive activity, as well as to many other neurobiological systems of different scales.

M I Rabinovich published dozens of papers and reviews, as well as several monographs that dealt with this subject and became deservedly popular among both physicists and biologists.

During these years, M I Rabinovich trained a large number of postgraduates and postdocs who are now studying nonlinear neural dynamics all over the world. This area has become one of the key ones in the Division of Nonlinear Dynamics and Optics of IAP RAS in his native Nizhny Novgorod. At the present time, M I Rabinovich continues working fruitfully in the same area at the University of California San Diego at the BioCircuits Institute.

In the 1990s, Mikhail Izrailevich Rabinovich was a member of the Supervisory Council of the OSI (Open Society Institute) Assistance Foundation, which helped hundreds of Russian scientists in the hard transition time. In 1994, M I Rabinovich organized the International Center— Foundation of Prospective Research in Nizhny Novgorod, later replicated by the Kurchatov Institute of Atomic Energy (IAE) and Saratov State University. These centers supported many significant interdisciplinary projects at the interface between physics, mathematics, biology, and engineering sciences.

M I Rabinovich is known for his uncanny ability to see before others a new prospective direction in nonlinear science and immediately delve into it. This is how it was at the dawn of his scientific carrier, when he was the first to apply the methods of the theory of self-oscillatory systems to the analysis of nonlinear 'autowaves' in distributed systems and media, then in his work on chaos in small dissipative systems, and in the nonlinear theory of cognitive processes. His interest in science is infectious, and therefore, many of his colleagues, both young and mature, whom he willingly 'feeds' with fresh problems and ideas follow him in this new directions.

Although Mikhail Izrailevich Rabinovich is first of all widely known as an outstanding theoretical physicist, he has always shown deep understanding and appreciation of experiment. At the IAP, Mikhail Rabinovich successfully guided a number of experimental projects, such as realization of chaotic dynamics in nonlinear electron chains, analysis of space–time disorder in parametric Faraday ripples, transition to chaos in thermal convection, as well as the application of an aerodynamic tube for the investigation of coherent structures in turbulence.

The range of Mikhail Izrailevich's interests has never been limited by science only. In his youth, he was an enthusiastic skier and successfully defended the honor of his native Gorky University at various inter-university competitions. Since his youth, and especially in recent decades, M I Rabinovich has composed poems. Eight collections of his poems have already been published, and the ninth will come out soon. In his poems, one finds inquisitive and original views on life such that allowed him

² This was the first review Mikhail Izrailevich published in *UFN (Physics–Uspekhi*), followed by another ten interesting and comprehensive *UFN* publications (see https://ufn.ru/ru/authors/465/rabinovich-m-i/). The 12th review (in co-authorship with P Varona), named "Nonlinear dynamics of creative thought. Multimodal processes and interaction of heteroclinic structures," has already been adopted for publication and is to appear in one of the upcoming *UFN*-2021 (*Physics–Uspekhi*) issues (see *Phys. Usp.* **64** (8) (2021)).

to make discoveries in science. Cordiality, warm-heartedness, a sense of humor, and infectious optimism have always attracted old and new friends of his.

On his 80th birthday, his friends and colleagues wish Mikhail Izrailevich many happy returns, good health, success, and many fruitful and interesting years of life.

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