Physics – Uspekhi **63** (10) 1043 – 1045 (2020)

PERSONALIA PACS number: **01.60.+q**

In memory of Vladimir Il'ich Talanov

DOI: https://doi.org/10.3367/UFNe.2020.09.038832

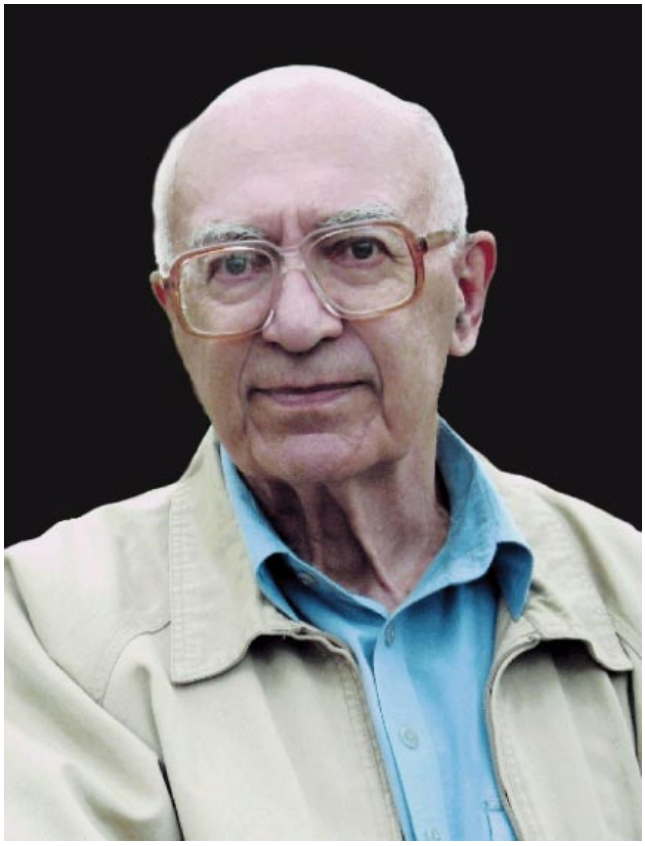
The outstanding Russian physicist, Academician Vladimir Il'ich Talanov, passed away on May 24, 2020 after a serious illness.

V I Talanov was born on June 9, 1933 in the town of Gorky (this was the name of Nizhny Novgorod from 7.10.1932 to 22.10.1990). On graduating from the Faculty of Radiophysics of Lobachevsky State University in 1955, he entered a university postgraduate program, where he continued his education under the guidance of professor M A Miller and carried out his first studies in the field of electrodynamics. The technology of superhigh frequencies (SHF) developing rapidly in those days required solving various problems associated, in particular, with diffraction and the excitation of surface electromagnetic waves. V I Talanov developed the theory of quasi-localized fields on low-curvature guide surfaces and was the first to obtain analytic solutions to the problems of diffraction excitation of surface waves. A series of these studies underlay his candidate thesis (1959). The theory of antennas with modulated surface impedance (formulated by him) made it possible to design effective high-directivity emitters with frequency steering of the directivity pattern at the Radiophysical Research Institute (NIRFI), where V I Talanov began working in 1957.

In the early 1960s, V I Talanov started Russian studies of the theory of open quasi-optical systems. He was the first to pay attention to the promising method of the parabolic equation for the theory of open waveguides and resonators, which he used to formulate the theory of mirror waveguides (1962–1964). An important contribution was the development of effective methods of oscillation selection in quasi-optical systems. This work, done within a short period, was recognized around the world and promoted Vladimir Il'ich to a leading position among world specialists in quasi-optics.

In connection with the appearance of lasers, especially topical in those days were the problems connected to nonlinear interaction and self-action of high-power optical radiation in different media. Precisely that avenue of research became the main one for V I Talanov in those 'nonlinear' 1960s–1970s, when quite new fields in the physics of wave processes were rapidly forming. He obtained a number of well-known results that underlay the theory of wave-beam self-focusing. Among them were self-similar solutions of the nonlinear parabolic equation (the nonlinear Schrödinger equation) for such beams in media with cubic nonlinearity (1964), a new class of invariant transformations and an analogue of the virial theorem for this equation that pointed to the sufficient condition for self-focusing of beams of arbitrary profile, the development of the general theory of space-time self-action of waves in dispersive media (1967), and a universal method of an averaged description of linear and nonlinear wave beams (the method of moments, 1971).

Uspekhi Fizicheskikh Nauk **190** (10) 1115 – 1116 (2020)
Translated by M V Tsaplina



Vladimir Il'ich Talanov
(09.06.1933 – 24.05.2020)

This series also included a fundamental result concerning the transverse instability of a plane wave in a nonlinear medium (1966) that leads to beam structure dissociation into separate self-focusing filaments and thus restricts the limiting possibilities of designing powerful laser systems (in the English-language literature, this result is often cited as the B integral (i.e., the break integral) criterion). In a series of later studies, he investigated theoretically and numerically the character of field singularity near the focus. All these fundamental results were further developed in the wave collapse theory that became a subject of great interest to physicists beginning in the mid-1970s.

On the basis of the pioneering work on linear and nonlinear quasi-optics, V I Talanov defended his doctoral thesis (1967). By that time, disciples and close colleagues began rallying around him to form a scientific school with quasi-optical methods of wave process analysis as the connecting methodological basis.

Along with the fundamental theoretical results, V I Talanov obtained a number of important experimental results in nonlinear optics. Almost simultaneously with analogous papers by American authors, V I Talanov and his colleagues

discovered the effect of spectral continuum (the so-called supercontinuum) generation under laser radiation self-focusing in glass samples (1970). It was only the disappointing misunderstanding of the review of this pioneering study, which had not only demonstrated a beautiful and unexpected effect, but for the first time had pointed out its origin, that did not allow its authors to have formal international priority. After that, in the mid-1970s, V I Talanov guided the implementation of a large series of applied studies on the nonlinear propagation of high-power lasing in atmospheric gases. These studies, in fact, laid the basis of a new field of science, namely, nonlinear optics of the atmosphere.

For investigations of electromagnetic wave self-focusing, V I Talanov (and colleagues) received the 1988 Lenin Prize. The series of his studies in this area laid the basis of his monograph (in co-authorship with S N Vlasov), *Self-Focusing of Waves* (1997).

With the appearance in 1977 of the Institute of Applied Physics (IAP) of the USSR Academy of Sciences, the further scientific biography of V I Talanov turned out to be connected with this institute, where he was head of the Department of Nonlinear Oscillations and Waves for many years and then the Department of Hydrophysics and Hydroacoustics. At the request of the founder and the first director of the institute, A V Gaponov-Grekhov, V I Talanov focused attention on wave processes in the ocean and methods of their diagnostics. This was a new field for him and for the institute. This 'switch over' showed clearly the characteristic feature of his scientific style, i.e., the skill to have a quick insight into the subject, to state the problems that are most important for its development, and to achieve key results.

One such problem in those days was to clarify the physical mechanisms of manifestation on the ocean surface of the hydrodynamic processes proceeding in the water body. V I Talanov proposed an adiabatic approach to the solution to the general problem of wave interaction of substantially different space–time scales that led him (together with his disciples) to the development of an effective model of the influence of intense internal waves on wind waves. The authors called this model kinematic. It became widely known to specialists and was repeatedly confirmed in nature studies carried out by research fellows at IAP RAS in different areas of the ocean and off-shore sea water. It was used to develop methods of remote diagnostics of the upper ocean layer.

In the first years of IAP work, the creation of an up-to-date experimental base was considered to be a necessary condition for the development of research in hydrophysics. Having proposed an original principle of water mass stratification in a laboratory tank on the basis of the temperature convection effect, V I Talanov made a considerable contribution to the solution to the problem. The method to create a stepwise density stratification conventionally used in world laboratories but strongly limited in its similarity to real conditions was ultimately radically replaced by the possibility of obtaining a gradient profile corresponding to the conditions of a real ocean (with allowance for the corresponding scale coefficients). Carrying out this pioneering idea resulted in the creation of a unique hydrophysical rig, namely, the large thermostratified tank at IAP RAS put into operation in 1991 after successful tests in smaller tanks. Using this installation, which was among the unique Russian setups of national significance and for many years had no equivalent in the world, a large series of fundamental and applied studies on physical modeling and diagnostics of wave processes in the upper layer of the real ocean was performed under the guidance of V I Talanov and then his disciples.

V I Talanov played an important role in conducting important applied work in the field of low-frequency ocean acoustics by IAP RAS in the mid-1980s. This work led to unique experimental results and substantiated the proposals concerning challenging systems of acoustic illumination of the underwater medium. In this work, which at first glance was hardly related to his former research, Vladimir Il'ich efficiently applied his rich quasi-optical 'arsenal' and physical intuition. One of the substantial results was his theory of radiating antenna synthesis in multimode waveguides whose role for sound waves in the ocean is played by underwater sound channels. Some of his proposals helped to considerably improve the characteristics of high-power hydroacoustic emitters, whose creation at IAP RAS was a 'cornerstone' of the elaboration of active systems of low-frequency hydroacoustics and allowed the institute to occupy a lasting position in this important field of applied studies.

In 1987, V I Talanov was elected a corresponding member of the USSR Academy of Sciences, and in 1992 he became a full member of the RAS. For his contribution to hydrophysical and hydroacoustic work, he was awarded the Order of the Red Banner of Labor (1989) and the medal 300 Years of the Russian Fleet (1996).

Beginning in the mid-1990s, at the suggestion of V I Talanov, the experience gained by IAP RAS in research and engineering in the field of acoustic diagnostics of the ocean was gradually 'converted' in a new direction, namely, seismoacoustic diagnostics. The experimental results obtained showed the possibility of constructing promising systems of seismoacoustic diagnostics with a high spatial resolution on the basis of efficient radiophysical approaches: the generation of coherent complex-modulated signals, methods of synthesized aperture, phase measurements, and correlation processing of weak signals. By analogy with coherent optics, where the key role is played precisely by coherent properties of laser radiation, this area received the name 'coherent seismoacoustics', and this stresses its scientific novelty and prospects.

Practically from the very beginning of his productive scientific activity, V I Talanov combined it with teaching at his *alma mater* at the Radiophysical Faculty of Nizhny Novgorod University, where he delivered the general course on the theory of the electromagnetic field and an original special course on the asymptotical methods of wave theory. Having taken the baton from his teacher, Professor M A Miller, Professor V I Talanov became head of one of the leading departments of the faculty — electrodynamics.

It would not be an exaggeration to say that Vladimir Il'ich Talanov was one of the brightest representatives of the radiophysical school of Nizhny Novgorod. His work made a fundamental contribution to many areas of the modern physics of wave processes. His deep understanding of the physics of waves in its various manifestations, an excellent mastery of mathematical methods and the rigorousness of analytical constructions, and an ability to single out the key link in a new problem and to suggest an efficient approach to its solution made his contribution to this field of physical science truly outstanding. But it was not only this that attracted his students and colleagues to him. Vladimir Il'ich was always benevolent and paid utmost attention to the opinion of his interlocutor, even a beginner. He tried rather to prompt the path of correct argumentation than to teach

literally, which made any discussion with him particularly useful. Many of those who happened to communicate with Vladimir Il'ich in discussing very different — not only scientific — questions noticed this characteristic of his. He always remained a gentleman in any situation — in the laboratory, in the lecture room, or around a campfire.

The death of Vladimir Il'ich is an irretrievable loss, not only for his relatives, numerous colleagues, and students, but for all of Russian science as well.

A V Gaponov-Grekhov, G G Denisov, V V Zheleznyakov,
V E Zakharov, V A Zverev, E A Kuznetsov,
A G Litvak, A I Malekhanov, E A Mareev,
O V Rudenko, A M Sergeev, E A Khazanov