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Oleg Vladimirovich Rudenko (on his 70th birthday)

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September 25, 2017 was the 70th birthday of the well-known physicist, academician of the Russian Academy of Sciences (RAS), professor at M V Lomonosov Moscow State University (MSU), laureate of State Prizes, and deputy editor-inchief of the journal *Uspekhi Fizicheskikh Nauk (UFN)* (*Physics – Uspekhi*) Oleg Vladimirovich Rudenko.

O V Rudenko made a world-acknowledged contribution to the development of nonlinear physics, acoustics, and a number of related applied areas; he has enriched science with important results in the field of nonlinear wave physics, laser physics, mechanics, geophysics, and biomedical and underwater acoustics.

The biography of O V Rudenko (hereafter OVR) is fairly well known to *UFN* readers for his *Personalia* entry published on the occasion of the 60th birthday in December 2007 in *UFN* [see *Phys. Usp.* **50** 1283 (2007); *Usp. Fiz. Nauk* **177** 1385 (2007)].

Neither O V Rudenko's biography nor the list of his scientific results obtained before 2008 has changed much since then, so we won't repeat them (those interested may look into the UFN site https://ufn.ru/ru/articles/2007/12/j/). Thus, we will dwell on information pertaining to the last decade.

All these years, OVR has continued to head the Acoustics Department at MSU. He also worked at the A M Prokhorov Institute of General Physics, at the O Yu Schmidt Institute of Physics of the Earth, occasionally at the N V Lobachevsky State University of Nizhny Novgorod, and in some other places.

For a long time, OVR was the chair of the Expert Council on Physics of the Higher Attestation Commission (VAK), a member of the VAK Presidium, and a member of the Council of the Russian Foundation for Basic Research (RFBR). OVR has focused greatly on publishing activity. Along with many years of great work for the journal UFN, where he is deputy editor-in-chief, he is also editor-in-chief of Akusticheskii Zhurnal of RAS and its English version, Acoustical Physics, and is member of the editorial Boards of other scientific journals.

OVR has also published his own work. In journals indexed in the bibliographical database Web of Science (WoS), he has published about a hundred papers over the last decade, which were for the most part written without co-authors.

The present-day tendency to intensify activity at an older age seems paradoxical at first glance. This phenomenon is now observed increasingly often and is due to the necessity to obtain grants and report on them. It may be the case that this is done at the expense of quality. Rephrasing Rutherford, it is appropriate to ask a question: if you are writing all the time,

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when are you thinking? This question can be addressed to authorities of organizations who are stuck in bureaucracy instead of science. But in competing for scientific grants (i.e., simply for the opportunity to devote oneself to science), one has to be realistic.

It should be emphasized that O V Rudenko was the only Russian person to win the 2011 mega-grant from the Russian Government. The grant was provided for five years, which made it possible to organize the Laboratory of Biomedical Technologies, Medical Instrument-Making and Acoustic Diagnostics at the University of Nizhny Novgorod (the head of the laboratory is Sergei Nikolaevich Gurbatov).

This laboratory is now one of the best equipped in the world with acoustic equipment. A number of patents have been obtained and several devices designed, of which two are already being produced in small batches.

After this, a team of researchers from several MSU departments headed by OVR won a grant from the Russian Scientific Foundation devoted to new acousto-optical metamaterials and the physical phenomena observed in them. Among them are acoustic analogs of double-negative "Veselago media" and structurally nonuniform materials with giant nonlinearity. Great attention has been given to meetings with physicians on both personal and methodical scientific problems. Many things shared with physicians are associated with elastography—a new diagnostic method for soft tissue and internal organs (see USA Patent, A P Sarvazyan and O V Rudenko "Method and apparatus for elasticity imaging using remotely induced shear wave," US Patent 5, 810, 731).

Industrial production of elastographs was set in motion by foreign corporations, but there are still few in Russia. Several papers had to be written for medical journals for a popular explanation of the underlying phenomena. The clinical results were discussed at conferences by the Union of Physicists and Physicians held on the basis of the Volga regional Medical Center in Nizhny Novgorod (S V Romanov, P I Rykhtik) and were reflected in the book, *Shear wave elastography: analysis of clinical examples* (edited by A V Borsukov), written by physicians with the participation of OVR (Smolensk: Smolensk city printing-house, 2017).

The work on engineering applications to biology and medicine are well cited abroad. For example, the basic study on elastography [A P Sarvazyan, O V Rudenko, et al. published in the journal *Ultrasound in Medicine and Biology* **36** 1379–1394 (1998)] has been cited more than a thousand times, although the theory of the phenomenon published by OVR in Russia two years before has only been cited three times.

OVR's biomedical patents received after 2008 were devoted to determining blood viscosity in the course of venipuncture (2014) with the use of capillary tubes (2014) and to a way of finding apolyproteins in blood plasma (2015). Furthermore, devices were designed for grouping nanoparticles (2011) and the methods developed for obtaining ordered nanostructures on a substrate (2011).

The results of the applied work on hydroacoustics have also patents, among which is "The method of seeking hydrocarbon on the shelf of northern seas" (2014) and "The underwater autonomous seismo-hydroacoustic station on the Arctic shelf water area" (2014).

The following results are presented in OVR's papers over the last decade:

(1) The work on mathematical physics is devoted to nonlinear integro-differential equations and equations with nonanalytic nonlinearities generalizing Burgers, Kortewegde Vries, Khokhlov–Zabolotskaya, Ostrovskii–Vakhnenko, and some other equations.

(2) Exactly solvable models describing interesting nonlinear structures and phenomena were constructed. Among them are stable shock rarefaction waves, modular solitons, and saw-tooth waves with trapezoid teeth.

(3) The meaning of the Landau–Slezkin solution for a submerged jet was clarified and its extension was obtained; this was needed to describe nonlinear acoustic flows and optimization of the operation of jet hydrocutting machines. The resonance regime for the technique of 'linear' friction welding was pointed out.

(4) The phenomena associated with acousto-microfluidics were studied. Strongly nonlinear elements were created for inclusion in the structure of artificial metamaterials and devices for sound absorption and frequency conversion.

(5) A number of statistical problems were solved. The propagation of intense noise waves in hereditary media like biological tissue and geostructures was studied. New exact solutions of Kolmogorov–Feller and Fokker–Planck equations were found.

(6) Work on the solution to nonlinear inverse problems was initiated. In particular, the space-time structure of the field on the emitter for the maximal thermal and radiation effect of focused ultrasound has been restored.

(7) Essential differences between (i) strongly nonlinear waves and (ii) weakly nonlinear waves with strongly pronounced nonlinearity were described. The truly strong waves were classified. Mathematical models were developed and examples were given.

(8) It was hypothesized that, along with the main function of skeletal muscle to convert chemical energy to mechanical energy, it is also able to protect bones and joints from injuries caused by shocks. Models of the reaction of a tense muscle to shock and the model of anisotropy of its elastic and dissipative properties were constructed. The results were confirmed experimentally.

(9) The theory of nonlinearities of solids with defects was formulated. The relation was found between electric and mechanical characteristics in the phase transition region. This relation is useful for remote probing of freezing natural media and for estimating ground endurance in the permafrost region. Experimental work on the nonlinearity of structurally nonuniform media is being performed at the MSU Center of Nonlinear Diagnostics (under the guidance of A I Korobov).

In OVR's opinion, a series of papers should end with the issuing of a monograph, and a lecture course with the writing of a textbook. With time, even a brilliant result presented in a paper is 'polluted with noise' from an oncoming stream of information.

To preserve knowledge and withstand the chaos encouraged by science-measuring centers and by the use of sciencemeasuring indices in the estimation of scientific activity, it is useful to publish books containing valuable and, something that is essential, systemized scientific information.

To get acquainted with a new field of science, scientists usually begin with good books and reviews, and only after that move to scientific journal sites on the Internet and their built-in search aids in the form of authors' indexes, subject headings and a simple or detailed search by key words. It may be asserted with high probability that our Russian school of brilliant universal theoretical physicists can hardly have appeared if it were not for the remarkable course of L D Landau and E M Lifshitz. Writing of books took much strength on the part of the classics of science, which they might have given to satisfy their personal scientific interests.

In the spirit of what has been said above, OVR wrote his first monograph when a postgraduate student more than 40 years ago. Its English translation was immediately published in USA. Then came other books, among which were both engineering and educational ones. After his 60th birthday OVR widened his collection as follows:

(1) Waves and structures in nonlinear nondispersive media (written together with Gurbatov S N and Saichev A I and published in Moscow (Moscow: Fizmatlit, 2008)). Its translation into English was published in China (Beijing: Higher Education Press, 2011) and Europe (Berlin: Springer, 2011).

(2) Nonlinear acoustics through problems and examples (written together with Gurbatov S N and Hedberg C M and published in Moscow (Moscow: Fizmatlit, 2009)). It was translated into English in Canada (Victoria, BC: Trafford, 2010).

(3) Anti-submarine underwater missiles. Physical problems and the history of creation of acoustic guidance systems (written together with Minaev A V and Romanovskii Yu M), published in Moscow (Moscow: MSU Publishers, 2011).

The first of the listed monographs was awarded the main prize of the MAIK/Nauka publishing house for a book edition.

Moreover, the second edition of the tutorial *Acoustics through problems*' was published in 2009 and the third edition of the textbook *Wave theory* appeared in 2015 (the book was translated into the Chinese language).

Many new scientific journals, collections, and proceedings of conferences are issued nowadays, presenting, unfortunately, a great deal of 'garbage,' as well as authors' repetitions and undisguised borrowings. To somehow withstand this 'blurred stream,' to improve the quality of the papers published in academic journals, to raise their citings, and to try to exclude the loss of valuable results of past years, OVR initiated activity on the formation of an archive of the *Acoustic journal* and a search system for required articles on acoustics.

Such an archive has been created by a group guided by V G Shamaev and can be found on the site http:// www.akzh.ru/ (see *Phys. Usp.* **58** 1124 (2015); *Usp. Fiz. Nauk* **185** 1235 (2015) and on the site https://ufn.ru/ru/ articles/2015/11/i/). This is probably precisely the way that Russian scientific journals should follow.

In recent years, OVR has written several review papers in Russian and foreign journals, including three papers for *UFN* (*Physics – Uspekhi*).

The scientific and organizational efforts of OVR have been appreciated by his colleagues. In 2015, OVR received the Order of Friendship "for merit in the development of education, scientific, and pedagogical activities and a great contribution to the training of qualified specialists" (from the reward announcement) and in 2016 he was honored with the title "Honorary professor of the University of Nizhny Novgorod."

Folk wisdom says that a necessary male feature is reliability! Oleg Vladimirovich possesses this feature in full measure. One can surely rely on him in a difficult situation. He will neither forget nor ignore, and he will never let you down. At a critical moment, he will shoulder the burden, and then retire modestly when the situation becomes normal.

Oleg Vladimirovich was born in the merry and sunny town of Tbilisi and remains optimistic, in spite of life's difficulties. It is always pleasant to interact with him and he inspires sceptics with optimism and belief in a bright future. For all this, OVR is loved and appreciated by his friends, colleagues, and acquaintances.

We wish Oleg Vladimirovich good health, good fortune, and further creative success!

M S Aksenteva, S N Gurbatov, A G Litvak, V Ya Panchenko, V A Rubakov, V A Sadovnichy, A M Sergeev, A L Sobisevich, N N Sysoev, A R Khokhlov, E V Chuprunov, I A Shcherbakov