

**To the 70th anniversary
of the Department of Electronics, Oscillations and Waves**

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Abstract. On June 1, 2022, the Department of Electronics, Oscillations and Waves of SSU turned 70 years old. Over the years, the Department has passed a brilliant way. Three of its leaders at different times were rectors of Saratov State University. Graduates and staff of the department are known in the scientific world not only in our country, but also far beyond its borders. We pay tribute to the Department of Electronics and remember the events, as well as all those people with whom we were somehow connected within its walls, and whose memory will remain in our hearts for a long time.

Keywords: education and science, Department of Electronics, synergetics, nonlinear dynamics, vacuum microelectronics.

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**Congratulations on the Anniversary of the
staff of the Department of Electronics, Oscillations and Waves**

*Head of the Department of Electronics, Oscillations and Waves
Ph.D., Associate Professor Sergey V. Grishin*

This year marks the 70th anniversary of the founding of the Department of Electronics at Saratov State University (SSU) named after N.,G. Chernyshevsky. After many years, the department has changed its original name, and now it is known as the Department of Electronics, Oscillations and Waves.

The department was headed at different times by three rectors of Saratov University:

1952–1953 — *Iemp Vasilievich Golubkov* — founder of the Department of Electronics, Honored Scientist of the Russian Socialist Republic, Head of the Department of General Physics, Director of the Research Institute of Mechanics and Physics (RIMF) SSU, Doctor of Physical and Mathematical Sciences (Doctor of Ph.D.), Professor;

1958–1980 — *Vladimir Nikolaevich Shevchik* — student of P. V. Golubkova, Ph.D., Professor, director and supervisor of RIMF SSU;

1981–2020 — *Dmitry Ivanovich Trubetskov* — student and successor of V. Shevchik, Honored Scientist of the Russian Federation, Corresponding Member of the Russian Academy of Sciences, Doctor of Ph.D., Professor.

The main purpose of the department was and remains the training of specialists in the field of vacuum microwave electronics, which in the post-war years was in great need of the newly created and rapidly developing "electronic bush which included enterprises of the defense complex.

However, the department trained not only specialists for the electronic industry, but also conducted extensive scientific and educational activities. The staff of the department participated in the implementation of research and development of the defense order, organized schools for specialists of the radio-electronic industry, and since the late 90s of the last century and to the present day they have been actively involved in fundamental research supported by leading Russian scientific foundations.

In December 1991, with the direct participation of Dmitry Ivanovich Trubetskov, the State Educational and Scientific Center "College" was organized, the director of which was appointed Yuri Ivanovich Levin — graduate of the Department of Electronics, Ph.D., Professor and associate of D., I. Trubetskov. Educational, scientific, editorial and publishing activities were carried out in "College". The educational process implied the presence of two levels of education. To implement the first stage (secondary education) in 1992, a decree was signed on the establishment of the College of Applied Sciences on the basis of secondary school No. 20, and in 1994, the Higher College of Applied Sciences, which is the second stage (higher education), was opened on the basis of Saratov State University.

In 1996, the Lyceum of the College of Applied Sciences was established. Later, on the basis of the Higher College of Applied Sciences Dmitry Ivanovich organized the Faculty of Nonlinear Processes (FNP), the dean of which was Yu. I. Levin, and the Lyceum of the College of Applied Sciences was renamed the Lyceum of Applied Sciences. Since December 2020, the Lyceum of Applied Sciences has been named after D. I. Trubetskov. Students who completed physical and mathematical training at the Lyceum of Applied Sciences could move on to the second stage of education at the FNP, where they deepened their knowledge in the field of dynamic chaos, the theory of nonlinear oscillations and waves, and self-organization. In fact, they were specialists with a "non-linear" view of the world around them, able to correctly analyze the processes taking place in nature and society and make the only right decisions. At the same time, ties with industrial enterprises and scientific institutes were not severed, leading specialists of which gave lectures to students and conducted practical classes. This made it possible to create a system of "school–

UNIVERSITY – enterprise" for training and securing personnel in the industrial and scientific fields. Such a system of training specialists in the direction of "Radiophysics" (profile "Microwave Physics") is still carried out at the Department of Electronics, Oscillations and Waves thanks to the efforts and innovative ideas of previous generations.

I heartily congratulate the staff of the Department of Electronics, Vibrations and Waves: Ph.D., Associate Professors Evgeny Nikolaevich Egorov, Dmitry Nikolaevich Zolotykh, Irina Sergeevna Rempen, Alexey Vladimirovich Titov, Vladimir Nikolaevich Titov, Associate Professor Mikhail Ivanovich Perchenko, Head of the educational laboratory Valentin Nikolaevich Skorokhodov, assistants Maria Denisovna Omelchenko, Anastasia Sergeevna Bir and Alexander Andreevich Funtov, as well as all those people who at one time graduated from this department or worked at it, happy 70th anniversary of the department!

The staff of the Department of Electronics, Vibrations and Waves would like to wish to preserve the educational and scientific potential that the department possessed in previous years, and adequately overcome all difficulties in this difficult time for the country and the department.

**Memories for the Anniversary. About the department and its employees.
Inviolability of traditions and continuity of generations**

S. V. Grishin

I was born, studied at school and entered the Saratov State University (SSU) named after N., G. Chernyshevsky even during the existence of the Soviet Union, when education, science and culture were not empty words for many. After graduating from secondary school No. 46 in 1991, I had no clear idea of my future profession, but in my heart I dreamed of going to university. The choice of the physical direction was predetermined largely thanks to my parents, who had a physical education and advised me to enroll in the Faculty of Physics without fail. At that time, one of the strongest departments at the Physics Faculty of SSU was the Department of Electronics, which trained electronics specialists for enterprises of the military-industrial complex of the city of Saratov. My parents were connected with the Department of Electronics in different years of their lives and spoke only good words about it. However, my choice fell on the Department of General Physics, headed by the Honored Scientist of the RSFSR, Doctor of Ph.D., Professor Vsevolod Semenovich Stalmakhov, who was a student of P., V. Golubkov. I was attracted by a new direction related to video electronics, which was then being developed at the department in cooperation with the Tantalus enterprise.

In the future, life turned out so that 8 years after graduating from the university, in 2005, I was accepted to the Department of Electronics, Oscillations and Waves as a senior lecturer, in 2006 I defended my PhD thesis under the guidance of Doctor of Ph.D., Professor Sharaevsky Yuri Pavlovich (he graduated the Department of Electronics together with Yu., I. Levin and was a graduate student of V., N. Shevchik) and a few years later became an associate professor of the department. In those years, the head of the department was Dmitry Ivanovich Trubetskoy, and of the «elders» Mikhail Alekseevich Grigoriev worked at the department, Yuri Dmitrievich Zharkov, Yuri Alexandrovich Kalinin, Yuri Grigorievich Gamayunov, Mikhail Ivanovich Perchenko.

M., A. Grigoriev headed the scientific direction "Acoustoelectronics and Acoustooptics" at the Department of Electronics, which began in 1967, when, at the suggestion of V., N. Shevchik, studies of excitation and propagation of hypersonic waves in crystals in the frequency range of 10 GHz were initiated at NIIMFa SSU. The first employees who worked on this topic were associate professors M., A. Grigoriev and Yu., A. Zyuryukin, graduate students V., I. Nayanov and V., A. Polotnyagin, technologist G., I. Pylaeva and others. In 1969 based on the conducted research, for the first time in the USSR, acoustic delay lines of a 3-centimeter radio signal operating at room temperature were created. In the period of 1972-1974, four scientific groups were formed, led by

Grishin S. V., Rempen I. S., Perchenko M. I.

M., A. Grigoriev, Yu., A. Zyuryukin, V., I. Nayanov, N., and I. Sinitsyn, who entered the laboratory of Acousto-electronics of NIIMFa SSU. Based on the research carried out in the laboratory, a number of devices using acoustic waves were developed: acoustic delay lines of radio signals of various ranges, acousto-optic line of variable delay and on its basis a simulator of a radar signal reflected from a moving object, receiving and transmitting sensors for acoustic microscopes, as well as acousto-optic laser radiation control devices: modulators, deflectors, filters. Most of them are implemented at radio-electronic enterprises.

Yu. D. Zharkov headed the scientific direction "Physical experiment in microwave electronics" at the department, which was organized in 1956 to create reverse wave generators without magnetic focusing. Under the guidance of associate professors B., M., Morozkov and L., E., Bakhrakh, a group of employees (Yu., D., Zharkov, M., A., Harit, L., Ya., Mayofis, B., S. Dmitriev) developed and created a number of reverse wave lamps with ion focusing of the electron beam in the decimeter, centimeter and millimeter wavelength ranges. Since 1964, a group of employees (B. S. Dmitriev, V. A. Rachkov, E. A. Umerov, A. E. Vasiliev, M. A. Dmitrieva, V. V. Bogolyubov, V. V. Zhigulin, V. N. Shlepkin and others, supervisor — Yu. D. Zharkov) a method of operational physical modeling of the interaction of charged particle flows with microwave fields was theoretically substantiated and developed. The method



Fig. 0. Профессор кафедры электроники, колебаний и волн Ю. Г. Гамаюнов

Professor of the Department of Electronics, Oscillations and Waves Yu. G. Gamayunov



Fig. 0. Профессора кафедры, доктора физико-математических наук Ю. Д. Жарков, М. А. Григорьев, В. С. Андрушкевич

Professors Yu. D. Zharkov, M. A. Grigoryev, V. S. Andrushkevich

Grishin S. V., Rempen I. S., Perchenko M. I.

Izvestiya Vysshikh Uchebnykh Zavedeniy. Applied Nonlinear Dynamics. 2022;30(6)

made it possible to carry out "hot" measurements

of the main parameters of decelerating systems and volumetric microwave resonators, to study linear and nonlinear wave processes in extended electron flows, to simulate powerful microwave devices, including relativistic, and high-current proton accelerators. For these purposes, a unique set of measuring instruments in the form of original electronic probes of various types was developed and created.

The scientific direction «Millimeter waves» traces its history back to the mid-1950s, when in SSU studies were started (which at various times were led by P. V. and- lubkov, Sh. E. Zimring, V. S. Andrushkevich) on the development of generators and amplifiers of the type O millimeter wavelength range and the study of the interaction processes in them of intense electron beams with RF fields of electrodynamic structures. In the 2000s, similar studies were continued by Yu. G. Gamayunov, who was the head of this scientific direction, A. I. Toreev, E. V. Patrusheva, and Professor V. S. Andrushkevich was a consultant. Based on the conducted research, electron-optical systems packaged with compact permanent magnets, as well as distributed resonance systems with distributed energy extraction were developed. Packaged four-resonator pulsed klystrons with distributed interaction have been created in the mid-wave part of the EHF band, providing pulsed output power of more than 3 kW, efficiency up to 30% and gain more than 30 dB, as well as five-resonator klystrons with gain up to 50 dB and gain band 0.35% at accelerating voltages 18 kV and beam current 0.5 A.

The powerful development of laser physics in the early 1960s did not pass by the young employees of the Department of Electronics D., I. Trubetskoy, B., G. Tsikin and L. I. Katz (later became an employee of the department), who together with V., A. Sedelnikov created a scientific student laboratory of SSU on quantum electronics. For B., G. Tsikin (Ph.D., Associate Professor of the department until 2002), this determined in the future one of the directions of scientific theoretical research of him and the group of NIIMFa employees headed by him — V., A. Dubrovsky, N., B. Lerner, A. P. Solovyov, A. A. Kolotyryna. This direction is — free electron lasers (LSE), the main advantage of which was the possibility of generating high-frequency radiation in a very wide

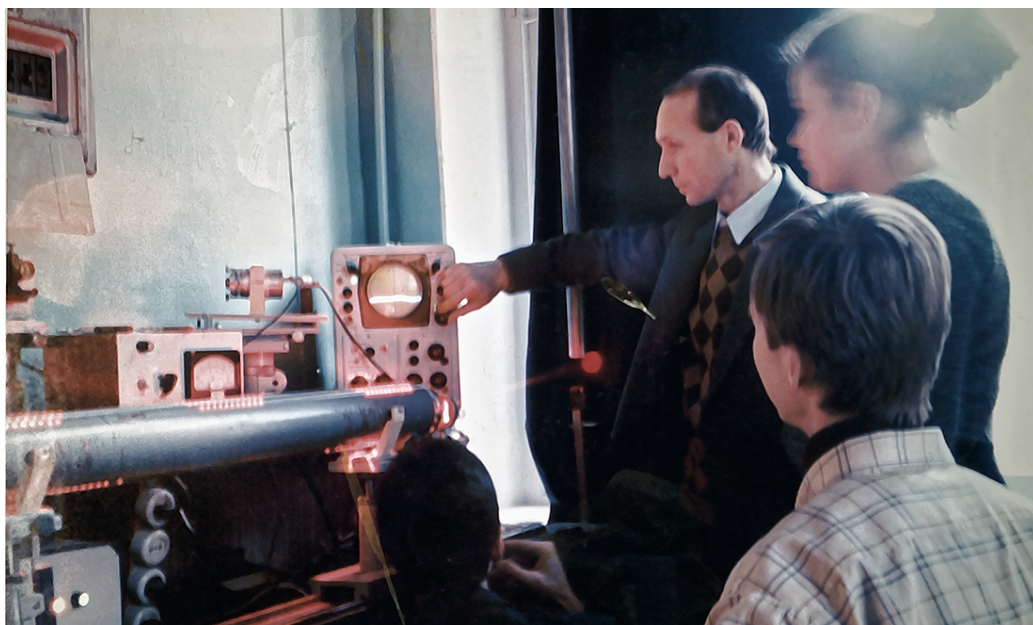


Fig. 0. Доцент кафедры электроники, колебаний и волн М.И. Перченко в практикуме «Квантовая радиофизика»

Associate professor of the Department of Electronics, Oscillations and Waves M. I. Perchenko in the laboratory «Quantum Electronics»

range of wavelengths — from microwave to X-ray. In the 1970s, within the framework of several reviews in the journal "Successes of Physical Sciences" the results of the work of the group of B., G. Tsikin were also discussed. One of the two methods of increasing the gain proposed in the works of the scientific group was thoroughly analyzed in the works of three employees of the Lebedev Physical Institute and the Institute of General Physics for optimal conditions for the generation of LSE, which, as it turned out, are achieved in relativistic electron beams. These works of Moscow physicists are attributed in the book "Russian physics of the Nobel level" 2006. (the authors of the book — K. N. Mukhin, A. F. Knyaznov, V. N. Tikhonov) to the significant achievements of Russian research in the field of LSE theory. Due to the fact that the world-class research of Moscow scientists was preceded by the work of a group of employees of B., G. Tsikin, is given by reference to the work of the group in the review, one of the authors of which was A. Yariv is a recognized authority in the field of quantum electronics. In Germany (Hamburg) on September 1, 2017, the world's largest European free electron X-ray laser ERLSE was launched (contribution of Germany 58%, Russia — 27%). Russian scientists have been given priority opportunities to work with ERLSE.

In addition to research on LSE, the members of the scientific group B., G., Tsikin (A., P., Soloviev, A., A. Knyazev, O., V. Zyuryukina, K., I. Svinolupov, D., E. Dolotov) developed and investigated original experimental methods of laser diagnostics of electron beams and plasmas with high sensitivity. In the theoretical works of B., G. Tsikin and S., S. Arkadasky (an employee of the scientific group of B., G. Tsikin), fundamental results were obtained on the theory of excitation of waveguides near the bandwidth boundary of decelerating systems. Associate Professor B., G. Tsikin developed and taught the course "Quantum Electronics" to students of radiophysics until 2002, which, after some changes and additions, was continued by senior lecturer M., I. Perchenko (since 2005 — associate professor of the department). Under the leadership of B., G. Tsikin and with the direct participation of M., I. Perchenko, a new workshop on quantum electronics was created and started functioning in 1974-1978. Today, the laboratory for quantum electronics is supported by M., I. Perchenko, who has preserved it as a unique workshop on quantum radiophysics for students of the Department of Electronics, Vibrations and Waves. Undergraduates of the last year perform here such works as "Electronic paramagnetic resonance" "Ruby optical quantum generator with modulated Q-factor" "Solid-state optical quantum generator" "Light diffraction on elastic waves in a crystal" "Open resonator" and "Helium-neon laser" (spare work — "Semiconductor laser").

From the first days of my work at the department, I was assigned to give a course of lectures on synergetics to students of the geological and biological faculties. At the same time, I conducted a wave workshop, practical classes in physical electronics, electronic and ion devices, as well as circuit engineering. Yuri Grigoryevich Gamayunov, with whom we conducted practical classes on physical electronics together, was amazed at such a variety of disciplines that "fell on me". But I, at that time a novice employee of the department, was very interested in all this, and I tried my best not to let the department down and conduct classes, as they say, conscientiously. I was friends with Alexander Evgenievich Khramov, who contributed to my appearance at the department. In 2005, he defended his doctoral dissertation on chaotic dynamics of the virkator and headed, together with Yu. A. Kalinin, the scientific direction at the department related to sources of broadband chaotic microwave signal. In the future, our paths with Alexander Evgenievich diverged. He went into neuroscience, and I remained faithful to the electronic theme.

Being engaged in experimental studies of nonlinear effects in passive magneto-electronics devices on magnetostatic spin waves (MSW) (power limiters and noise cancellers on MSW) in a scientific group headed by Professor Yu., P. Sharaevsky, I was far from dynamic chaos. But it was during these years, under the influence of the "chaotic" direction of the Department of Electronics, that I began to look for an opportunity to create sources of dynamic chaos on MSW. This hobby of mine was also dictated by the fact that my father, Valery Sergeevich Grishin, at one time was

also engaged in the development of broadband noise-like signal sources at the Volna Research Institute, where he headed a laboratory working in this direction. Dad had close scientific ties with the university.

In the laboratory of V., S. Grishin in the early 80s of the last century, independently of the IRE of the USSR Academy of Sciences, work was completed on the creation of sources of a noise-like microwave signal on bipolar transistors for radio transmission systems in the meter, decimeter and centimeter wavelength ranges. But the political crisis that broke out in our country put an end to these developments. I wanted to "pick up the banner that fell out of my hands" and try to create similar sources that work on other physical principles. It turned out that in the scientific group of Boris Antonovich Kalinikos, Ph.D., Professor of the Leningrad Electrotechnical Institute (LETI), at the end of the 1990s, the possibility of obtaining a chaotic signal in a ring autogenerator was theoretically and experimentally demonstrated in the feedback circuit of which a nonlinear delay line on the MSV was used, supporting a three-wave parametric decay of long-wave MSW into shorter-wave spin waves. Having assembled a similar generator circuit, we saw, that this source is relatively broadband (with a frequency band of ~ 1 GHz) and, most importantly, it has a fairly high efficiency (15-20%), unlike all other known designs of noise-like signal generators. In such a generator circuit, an amplifier on high-power field-effect transistors operated in linear gain mode near a point with the highest possible efficiency, and chaotic dynamics was determined only by the nonlinearity of the spin-wave line. These results were immediately reported at the scientific seminar of the department and aroused interest not only among young specialists of the department, but also among the "watchmen" of the generator direction, among whom were professors Yu. A. Kalinin and Yu. D. Zharkov.

Yuri Dmitrievich Zharkov together with Boris Savelyevich Dmitriev (who worked for a long time at the Department of General Physics) were engaged in experimental studies of the chaotic dynamics of a ring generator assembled on the basis of a multi-resonator span klystron. Dmitry Ivanovich spoke about this generator as another "100-dollar idea" that gave the span klystron a second life. However, not everyone was so supportive of the research conducted in the scientific group of Zharkov-Dmitriev. I remember our trip to the Crimea in the early 2000s to the conference, where Boris Savelyevich, as he put it later, had a "fan" in the person of Yevgeny Anatolyevich Myasin. Evgeny Anatolyevich made it clear that everything that Boris Savelyevich tells has been known for a long time and a similar principle of obtaining a chaotic signal was developed in the 1960s at the IRE RAS and formed the basis for the creation of a "noise generator" — a microwave generator made on traveling wave lamps. Boris Savelyevich calmed Evgeny Anatolyevich in every possible way and said that in no case does he claim the palm in this direction, but tries to show that the method that was used in the "noise meter" scheme on the LBV can also be used to obtain a chaotic signal in the autogenerator on the span klystron. After that, all misunderstandings were removed. Later, Dmitry Ivanovich asked E. A. Myasin to read a lecture on "noise reduction" ("Research of microwave noise generation in the IRE of the USSR Academy of Sciences of 1962-1967 — the beginning of a new scientific direction") at the X International School "Chaotic self-oscillations and the formation of structures which was held in Saratov in a boarding house «The Volga Gave» in October 2013.

Yuri Dmitrievich and Boris Savelyevich devoted a lot of time to a physical experiment, which was sometimes carried out in very difficult living conditions. Their laboratory of physical experiment in microwave electronics was located on the 1st floor of the 8th building of SSU, on the former NIIMFa squares, in room No. 42 (now, after the unification of the three physics faculties into the Institute of Physics — this is room No. 115), which was very poorly heated in the early 2000s in winter, as well as most of the laboratories of the former NIIMF. In winter, the indoor

temperature did not rise above $+15$ with $^{\circ}$. I remember how Yuri Dmitrievich, Boris Savelyevich and Valentin Nikolaevich Skorokhodov (head of the educational laboratory of the Department of Electronics, Oscillation and Waves) in winter clothes, hats and gloves sat at the installation and, joking with each other, conducted an experiment. Sometimes it seemed to me that they did not even notice the conditions in which they were working, so enthusiastically they discussed the staging of the experiment, and then the results obtained. They so "infected" the people around them with their enthusiasm that one of the 5th-year students (then still a specialist) of the Faculty of Nonlinear Processes (FNP) asked Boris Savelyevich to give her a thesis, which certainly had to be devoted to a radiophysical experiment. This student was Olga Khilyushkina, who brilliantly defended her thesis and became, probably, the first student of the FNP who refused numerical modeling that had already filled her teeth and took up conducting a radiophysical experiment with a klystron autogenerator. The results of experimental studies with klystron chaos generators obtained in the group of Zharkov–Dmitriev formed the basis of two doctoral dissertations (N.,M. Ryskin and B.,S. Dmitriev).

I joined the klystron theme only in 2009, when, together with the scientific group of Zharkov–Dmitriev, an experiment was set up on autonomous generation of chaotic radio pulses while simultaneously using both a flying klystron and a spin-wave delay line in the ring. I was very pleased with this cooperation, as it made it possible to move on to the study of nonlinear effects in hybrid generator circuits containing vacuum and solid-state elements. This direction was further developed 8 years later, when in 2017 Dmitry Ivanovich proposed to Valentin Nikolaevich Skorokhodov and me to use the LBV operating in the Compfner breakdown mode as a saturating absorber for generating sequences of ultrashort pulses (UCI) of the envelope. By this time M., A. Grigoriev and Yu., D. Zharkov had already passed away. However, Boris Savelyevich supported our initiatives in every possible way and was constantly interested in the results obtained, even despite the health problems he had by that time. After all, the candidate's dissertation B. S. Dmitrieva, which he defended in 1966 under the leadership of Yu. D. Zharkov, was devoted, among other things, to the study of the Compfner breakdown. On a ring generator circuit with two LBV (amplifier and suppressor) and a bandpass filter, we were unable to obtain a passive mode synchronization mode, but when we added a nonlinear spin-wave delay line to the circuit with a nonlinear LBV suppressor, and installed span klystrons at the input of each nonlinear element as amplifiers, we received the generation of the CCI. However, in this case, more complex pulse structures were generated, arising due to the Q-factor modulation of the ring resonator by both spin waves and a saturating absorber. This led to chaotic modulation of the periodic sequence of UCI by spin waves, as a result of which chaotic sequences of spin-wave pulses of long duration were formed, in which periodic sequences of the envelope UCI were "embedded". All this was very interesting, besides, this interest was "fueled" by the theoretical works of Professor Nahum Samuilovich Ginzburg from the Institute of Applied Physics of the Russian Academy of Sciences (Nizhny Novgorod). Dmitry Ivanovich was very pleased with our success, because the failure of the Compfner is on the emblem of the department and is, in a way, its symbol.

The Department of Electronics had a significant impact not only on my fate, but also on the fate of my parents. In the mid-1960s, my mother was a student of the department, where Ph.D., associate Professor Yuri Dmitrievich Zharkov lectured, and practical classes were conducted by a young graduate student of the department Nikolai Ivanovich Sinitsyn (graduate student V.,N. Shevchik, a friend from school, D.,I. Trubetskova, D.F.–M.Sc., Professor, Honored Scientist of the Russian Federation and Laureate of the State Prize of the RF). In 1973, my dad presented his dissertation work at the famous scientific seminar of the department headed by V.,N. Shevchik. His supervisor was Albert Markovich Katz (also a graduate of the Department of Electronics), who at that time headed the theoretical department of the Research Institute "Volna and one of

the official opponents of the dissertation work — D., I. Trubetskov. Finally, my wife graduated from the Department of Electronics, Oscillation and Waves and is currently working at this department. In fact, the Department of Electronics has become a second home for our family, filling our lives with meaning and harmony.

Over the past 10 years, the staff of the Department of Electronics, Oscillation and Waves has been significantly updated. D. I. Trubetskov, M. A. Grigoriev, Yu. D. Zharkov, Yu. A. Kalinin and A. P. Solovyov have passed away. For various reasons, they left the department of Ph.D., Professor A. E. Temples, Ph.D., Professor A. A. Koronovsky, Ph.D., Professor Yu. G. Gamayunov and Ph.D., associate Professor G. M. Vdovina. However, new young employees also appeared: Ph.D., Associate Professor A., V. Titov, assistants A., A. Pounds, M., D. Amelchenko and A., S. Bir. Today there are two scientific directions at the department. One of them is traditional for the department — this is the direction of "Vacuum microwave electronics which is supported by students and followers of D., I. Trubetskov (Ph.D., associate professors of the department A., V. Titov, V., N. Titov, I. S. Rempen, E. N. Egorov, head. educational laboratory V., N. Skorokhodov, assistant A., A. Funtov), and the other is relatively new — this is the direction "Spin-wave electronics and magnetic metamaterials which is supported by Ph.D., associate Professor S., V. Grishin, assistants and graduate students of the department M. D. Amelchenko, A. S. Bir and A. V. Bogomolova. Talented young people who have come to work at the department actively participate in the implementation of grants of the Russian Foundation for Basic Research and the Russian Academy of Sciences, and the successes of some of them (Bir A., S.) in the academic and scientific life of the department have been recognized in the form of an individual scholarship of the Government of the Russian Federation.

Time does not stand still. I want to believe that after the next 10 years, the department will celebrate its 80th anniversary, and the current youth who have come to work at the department will worthily continue and maintain its traditions.

Memories of a good person

M. I. Perchenko

Traditionally, when writing down memories of the department, we first of all remember the teachers, and often forget the people without whom the work of the department would actually be impossible — about those who are listed in the personnel department under the dry words «technical staff». I would like to tell you about one such person who was part of the Department of Electronics from the very moment of its appearance. This is Pavel Vasilievich Mozhaev, who held the position of senior laboratory assistant at the time when I started working at the department — a tall, thin man, a front-line soldier, a knight of the Order of Glory of the III degree. All 13 works in the workshop "Electronic and ion devices which is still functioning at the department, it was he who embodied "in hardware" in an excellent schematic and design design and with a high degree of reliability. He was, as they say, a jack-of-all-trades: an electrical engineer, a radio engineer, an artist-designer, a locksmith, a carpenter, a turner, etc., etc. At the same time, he made almost all his products and crafts from parts, cases and "insides" of devices, devices, equipment that had served their time, in general, everything that he himself called "foot food". It was he who made the emblem of the department on a plastic shield, from which employees went to the November and May demonstrations during the USSR, made all kinds of badges, stripes, key rings for holidays, anniversaries and all kinds of events.

He was an exceptionally modest and laconic person. For example, he told about his combat wound like this: «Yes, the fragment flew by, touched the jaw; so to speak, corrected a little» (he said this with a slight grin and ran the back of his hand along the deformed jaw). About his award

Grishin S. V., Rempen I. S., Perchenko M. I.

on the website «Memory of the people» I read it: «in the battles in the village of Wasserborn, with the German invaders, on the west bank of the Oder River from 27 to 31.1.45 — where the battalion captured a bridgehead — comrade. Mozhaev, as part of the calculation, repelled 2 fierce enemy counterattacks. 29.1.45 of the year — the Germans especially cruelly climbed into the counterattack, the mines ran out — comrade.Mozhaev, along with the calculation, with rifles in his hands, resolutely repel this counterattack, destroying 20 Hitlerites at the same time. In this battle, Comrade. Mozhaev was wounded, but after bandaging he returned to the ranks and continued to repel enemy attacks ».

P.,V.Mozhaev began working at SSU in June 1947, first as a laboratory assistant, then as a senior laboratory assistant, later as head of the laboratory. In the 1970s, a new workshop on quantum electronics began to form at the department. Pavel Vasilyevich has repeatedly advised me when setting up laboratory work in this workshop, while demonstrating his highest qualifications and skills.

That's what I want to say — our land rests on such people.

Oscillation, waves, electrons

I. S. Rempen

My life has been connected with the Department of Electronics since 1991, when, on the advice of Dmitry Ivanovich Trubetskov, who knew my mother well, I entered the physics Department of Saratov University. A certain role in my decision was also played by the fact that my classmate was the son of one of the «electronics engineers», old graduates of the department, Vladimir Alekseevich Isaev, who, by the way, was among the organizers of the very first Schools-seminars on microwave electronics in Saratov. V. A. Isaev then impressed us, schoolchildren, a great impression with his stories about physics and about life.

Admission to the Faculty of Physics was very large at that time, more than 300 people, divided into two streams - physics and radiophysics. The Department of Electronics and Wave Processes (as it was called at that time) and the Department of Radiophysics recruited more than 30 people, who were divided into three groups. I still remember the numbers well: groups 121, 122 belonged to the Department of Radiophysics, 123 and 124— to the Department of Electronics. I got into a mixed group 122/123, in which students of both departments studied together until the 5th year. There were only three girls in the group of twenty students, and after the first session there was only one me.

The educational process then began not from September 1, but from October 1, and in September students went to the collective farm for harvesting. 1991 turned out to be the last year when Saratov University students were sent to the collective farm. This trip left exceptionally pleasant memories for me and my classmates. Spartan living conditions and the need to go out into the field and harvest cabbage for several hours a day did not bother us at all at the age of 17-18. And the rest of the time was filled with communication, songs to the guitar. This month gave us the opportunity to meet and make friends with new comrades.

University studies were at first largely unusual. Two large buildings connected by a passage, in which at first it was possible to get lost. Lecture notes that had to be written continuously until the hand got tired. Higher mathematics, physical disciplines that were much more difficult at school level for everyone except graduates of mathematical special school No. 13 (future FTL).

I remember with what interest we read the list of term papers posted at the department for the 1st course. There were so many mysterious words unfamiliar to us, for example, «phase portrait». I signed up for a coursework to D., I. Trubetskov, which was no less intriguing for a

freshman name «High-speed modulation and grouping of electronic flow» and was dedicated to familiarizing myself with the work of the span klystron.

At that time, a very strong team was selected at the Department of Electronics. In addition to the head, corresponding member of the Russian Academy of Sciences D., I.Trubetskov, professors Dmitry Yuryevich Zharkov, Mikhail Alekseevich Grigoriev, Vladimir Stepanovich Andrushkevich, as well as associate professors Yuri Grigoryevich Gamayunov, Boris Gennadievich Tsikin — all old «electronics» worked at the department. Students of the department received very strong knowledge of microwave electronics, including such specialized courses as «Electronic and ion beams» (Yu. D. Zharkov), «Solid-state microwave electronics» (M. A. Grigoriev), «Computer-aided design of radio-electronic devices» (Yu. A. Kalinin). In the 5th year, a special course was also introduced «Modern problems of radiophysics and the science of vibrations and waves», in which young specialists of the department took turns reading us small courses on scientific problems that they themselves were engaged in. The youngest of such specialists was A. Koronovsky, who immediately after graduating from university and entering graduate school was assigned a small course related to nonlinear models of dynamical systems of various nature.

The 1990s were a very difficult, critical time. If in previous decades there was a distribution of jobs for university graduates, and they clearly understood their employment opportunities, then with the collapse of the Soviet Union this system was destroyed. Graduates were forced to get a job themselves, and most — are not in their specialty at all. For many of my classmates, it became a psychological trauma — in 1991 to finish school and go to university with the thought «I will be a physicist», and already in senior years to look for a job somewhere in trading firms or urgently finish accounting courses.

During this difficult time, loyalty to my chosen profession, to the university, was extremely important to me. I entered graduate school with D., I.Trubetskov and took up numerical modeling of distributed wave systems. But life made its adjustments again, and in the second year of graduate school I went on maternity leave. At the same time, Dmitry Ivanovich held the position of rector of Saratov University, his workload was huge, which forced graduate students to rely for the most part only on themselves. But in 2001, an event occurred that became decisive in my life. As I have already mentioned, due to the severe economic crisis of the 1990s, many employees left the department, including young associate professors Vasily Gennadievich Anfinogentov and Alexey Alexandrovich Kipchatov. And Alexander Evgenievich Khramov, who was acting as the deputy head of the department at that time, invited me to return to the department as an assistant, and also to do scientific work under his supervision related to numerical modeling of some microwave electronics systems. I agreed. Although traditionally young employees starting to work at the department conducted only seminars and laboratory classes, but I immediately received a lecture course «Electronic and ion devices», as well as a complex and responsible cathedral duty to calculate the workload, which I subsequently did for many years. It was not easy, but very interesting years at the new young faculty (I left the physics department for a decree, and returned to the faculty of nonlinear processes), passed in a wonderful and friendly scientific team under the leadership of Alexey Alexandrovich Koronovsky and Alexander Evgenievich Khramov. Soon talented young employees Evgeny Nikolaevich Egorov, Anastasia Evgenievna Khramova, Olga Igorevna Moskalenko, Gennady Borisovich Astafyev, Semyon Andreevich Kurkin, Alexey Alexandrovich Ovchinnikov and others joined the team.

In 2007, I defended my PhD thesis on topics related to nonlinear oscillations in electronic flows and their control using external signals and various types of feedback. Part of the dissertation material obtained under the guidance of Alexander Evgenievich Khramov, by that time already a doctor of physical and mathematical sciences, was included in the monograph of D., I.Trubetskov, A., E.Khramov «Lectures on microwave electronics for physicists», which students of the

Department of Electronics have been studying for almost twenty years. Valuable discussions of the tasks to be solved with Professor of the Department Yuri Alexandrovich Kalinin were also very useful for the work. In his research group, experimental results on the dynamics of electron flows were obtained, which demonstrated an interesting coincidence with the numerical results of my work. Since the dissertation used traditional methods of radiophysics and nonlinear dynamics, and also considered physical processes occurring in electronic flows, it was decided to submit a dissertation in two specialties — «Radiophysics» and «Physical Electronics». This decision was prompted by the work of the scientific supervisors of the work of — Dmitry Ivanovich Trubetskov and Alexander Evgenievich Khramov. The opponents of the dissertation were Doctors of physical and mathematical Sciences V.,B.Kazantsev (Nizhny Novgorod) and B.,E.Zhelezovsky (Saratov). The autumn of 2007 was difficult but fruitful for the department — at that time, the dissertation for the degree of Candidate of Physical and Mathematical Sciences was also defended by the assistant of the department Evgeny Nikolaevich Egorov.

Nonlinear dynamics and synergetics as a scientific direction of the department. It should be noted that the main scientific direction of the department — ultrahigh frequency electronics — from the very beginning of its appearance was closely connected with such fundamental areas as the theory of oscillations and waves, the theory of nonlinear processes. Since the 1960s, the theoretical and experimental study of oscillatory and wave processes has received significant development at the department, which was reflected in the change of its name in 1986 to «Department of Electronics and Wave Processes». In 1984 the publishing house «Science» published a monograph by M. I. Rabinovich, D. I. Trubetskov «Introduction to the theory of vibrations and waves », which was of a fundamental nature, was soon translated into English, subsequently withstood



Fig. 0. Научный семинар кафедры электроники, колебаний и волн, 2014. Слева направо: А. Г. Рожнев, Е. Н. Егоров (ведущий семинара), Д. И. Трубецков, Ю. А. Калинин, О. И. Москаленко, С. В. Гришин, А. А. Короновский

Research seminar of the Department of Electronics, 2014. From left to right: A. G. Rozhnev, E. N. Egorov, D. I. Trubetskov, Yu. A. Kalinin, O. I. Moskalenko, S. V. Grishin, A. A. Koronovkii



Fig. 0. Встреча преподавателей кафедры электроники, колебаний и волн с первокурсниками. Слева направо: В. Н. Скороходов, Е. Н. Егоров, А. Е. Храмов, Д. И. Трубецков, А. В. Титов, Г. М. Вдовина, М. И. Перченко, А. П. Соловьев

Meeting of teachers of the Department of Electronics with first-year students. From left to right: V. N. Skorokhodov, E. N. Egorov, A. E. Hramov, D. I. Trubetskov, A. V. Titov, G. M. Vdovina, M. I. Perchenko, A. P. Soloviev

several more reprints and still has not lost its significance. We can say that electronics was one of the first to become a "nonlinear" science, using various methods of nonlinear dynamics for its tasks. One of the manifestations of the close connection between electronics and modern nonlinear science is that neither one nor the other is possible without a numerical experiment, which had a great influence on the development of this direction at the Department of Electronics and at the NIIMFa SSU [1]. The successes of nonlinear science have led to the fact that specialists in the field of microwave electronics have begun to pay great attention to the study of typically nonlinear phenomena in electronic flows interacting with electric and magnetic fields: modes of occurrence of dynamic chaos, solitons, fractal objects, the formation of structures. This also affected the educational process: training courses related to linear and nonlinear oscillations and waves were expanded, new disciplines appeared, such as «Dynamic systems and bifurcations», «Dynamic chaos», «Theory of Catastrophes», which were developed and conducted at the faculty of Professor Boris Petrovich Bezruchko, Sergey Petrovich Kuznetsov, Alexander Petrovich Kuznetsov, Alexander Petrovich Chetverikov, young employees of the Department of Electronics Leonid V. Krasichkov and Elena Sumbatovna Mchedlova. At the end of the 1990s, a new laboratory workshop was organized at the department «Waves, structures, self-organization», through which more than 200 physics students passed a year. Boris Petrovich Bezruchko, Professor of the Department of Electronics, became the head of the workshop, and his valuable contribution to the work of this laboratory can hardly be overestimated. Visual and spectacular works «Convective structures (Benard cells)», «Faraday ripples», «Electromagnetic solitons», «Autowaves and structures in chemical systems ("iodine clocks")», «Self-modulating phenomena and chaos in the reverse wave lamp» have become a new significant step for the department in teaching «nonlinear science».

In 2001, a new workshop appeared at the department «Applied nonlinear dynamics in electronics», which allows students to acquire valuable practical skills in working with electronic circuits, as well as to study various oscillatory and wave phenomena in low-power radio circuits. The post-graduate student Evgeny Nikolaevich Egorov, who was then an engineer of the department, was appointed responsible for the workshop. Over the past years, eight papers have been delivered in the workshop, methodological manuals for them have been written and published by the staff of the department, and the possibilities of the workshop are far from being exhausted.

Grishin S. V., Rempen I. S., Perchenko M. I.

Dmitry Ivanovich Trubetskov has always been in the trend of the newest, advanced ideas of science, and not only in a highly specialized, but also in the broadest sense. After the publication in 1977 of the book by G. Haken «Synergetics», many scientists became interested in the new approaches that this branch of nonlinear dynamics represented — the science of the formation of structures in complex systems. It was not the nature of a particular system that came to the fore, but the principles of its functioning. By the 1990s, thanks to the works of I., S.Prigozhin, N., N.Moiseev, V., I.Arnold, Yu., A.Danilov, the ideas of interdisciplinarity, the possibility of applying a general mathematical apparatus and techniques to describe systems of a very different nature were widely spread. This was reflected in the activities of the Department of Electronics and Wave Processes by creating a unique interdisciplinary course «Synergetics», which was read by the staff of the department for students of philosophical, Economic, geological, socio-humanitarian faculties, Faculty of Computer Science and Information Technology [1]. Under the leadership of A., E.Khramov and A.,A.Koronovsky, a computer workshop was also created, which included the demonstration and study of experiments on the formation of structures in open systems of physical and chemical nature. I was one of the first students actively involved in a new direction. At the initiative of Dmitry Ivanovich, in the 5th year I was engaged in modeling systems of various nature, and my thesis was devoted to the development of mathematical models for the dynamics of some biological, ecological and economic systems. Subsequently, like all young employees of the department, I conducted part of the extensive academic load associated with the course «Synergetics». Together with other departments of SSU, the Department of Electronics also held interdisciplinary scientific conferences that affected not only natural sciences, but also humanities. The result of this activity was the award to D., I.Trubetskov of the Presidential Prize in education for the creation of a system of teaching natural sciences to humanities and the creation under his leadership of a scientific school on nonlinear dynamics [3]. Also on the initiative of D., I.Trubetskov, Head of the Department of Electronics, in 1993, a unique journal was created in SSU, the only one in Russia with a «nonlinear-dynamic» topic — «News of Universities. Applied nonlinear dynamics».

Schools and conferences. In addition to scientific and teaching activities, the staff of the Department of Electronics has always devoted a lot of effort to organizing scientific events, the participants of which were both well-known lecturers and young scientists. First of all, one of such events should be called winter Schools-seminars on ultrahigh frequency electronics for engineers and scientists. The first such school took place in 1970, and since then they have been held regularly every 2-3 years. The popularity of these schools began to grow rapidly, the geography of participants expanded each time. Over the past years, such prominent scientists as L.,A.Weinstein, Lenin Prize laureate D., M.Petrov, V., T. Ovcharov, R.,A.Silin, M., I.Rabinovich, and, of course, the head of the Department of Electronics V., took part in them. N. Shevchik and almost all physicists are «electronics engineers» from Saratov University and other Saratov universities and research institutes [2]. Almost all of the lectures were original in nature, they outlined tasks and results that had not yet been published for the most part. The program of the schools was so intense that classes continued from morning until late at night. Subsequently, in addition to the lecture part, the seminar school began to include small breakout sessions with scientific reports, as well as poster sections with messages from young scientists. Since Dmitry Ivanovich became the head of the Department of Electronics, he has always been actively engaged in the popularization of science, involving his other colleagues in this. So, in 1988, the idea of holding unique events appeared — visiting scientific schools for schoolchildren, where talented high school students interested in science could «first-hand» get acquainted with modern scientific trends and achievements, and perhaps see their future path to science. The first schools, called «Oscillations, waves, electrons», began to be held every two

years during the autumn holidays in the Saratov boarding house «Volga Distances». Students from schools in Saratov and Engels, as well as from district centers and villages, were involved in them. Any student who submitted an application and sent a solution to the pre-distributed competitive tasks could become a participant of the school. Participation in the event was free for schoolchildren.

The participants of the schools listened to lectures by famous physicists, where new and unusual physical problems and interesting facts from the history of physics were presented in an interesting accessible form. In addition to the teachers of SSU, the organizers attracted interesting people from other cities to the work of schools. Prominent historian and popularizer of science, Professor of Moscow State University Yuli Aleksandrovich Danilov, Professor of the Hematology Research Center of the Russian Academy of Medical Sciences Georgy Theodorovich Guria, Professor of the Institute of General Physics of the Russian Academy of Sciences Natalia Alexandrovna Irisova were frequent guests at the schools.

In addition to lectures, students were also waiting for seminars dedicated to solving problems, a small computer class specially equipped for the duration of the school (which in the 1980s-1990s was unusual for many, especially rural schoolchildren), intellectual games (the game was traditionally held «What? Where? When?»), academic meetings, round tables, discussions, as well as a large amount of informal communication in a relaxed atmosphere. This communication took place during walks in the park of the boarding house in beautiful autumn weather, during breaks between lectures or during «scientific tea parties», held in the free evening in an informal



Fig. 0. Лекторы и «водители» школы «Колебания. Волны. Электроны» для одаренных школьников. Пансионат «Волжские дали», 1995. Слева направо: Юлий Александрович Данилов, Дмитрий Иванович Трубецков, Денис Захаров, Ирина Ремпен, Елена Коробова (Трубецкова), Екатерина Мельникова, Наталия Михайловна Астафьева, Дмитрий Громов, Владимир Титов, Вероника Иосифовна Лабунская, Антон Попов, Евгений Смирнов

Lecturers and counselors on the School "Oscillations. Waves. Electrons", 1995. From left to right: Yu. A. Danilov, D. I. Trubetskov, D. Zakharov, I. Rempen, E. Korobova, E. Melnikova, N. M. Astafyeva, D. Gromov, V. Titov, V. I. Labunskaya, A. Popov, E. Smirnov

setting somewhere in the lobby or room of the boarding house. Schoolchildren, who were divided into small groups of 10-12 people for the convenience of working with them, took turns inviting two or three lecturers to their place, and in such a relaxed atmosphere, conversations on a variety of scientific and near-scientific topics were conducted late into the night. Dmitry Ivanovich Trubetskov and Yuli Alexandrovich Danilov were the most beloved guests of such tea parties, the participants of the schools were joking among themselves for the right to invite them to their place.

Traditionally, students of the Department of Electronics were also involved in working at schools. While studying at the university, I visited two such schools — in 1993 and 1995. A student was assigned to each «squad» of schoolchildren as a «counselor». We helped organize the day of school participants, their schedule, solved problems with them, attended lectures and scientific tea parties with great interest, were engaged in the preparation and conduct of intellectual games, and also collected material daily, wrote notes and published the school's wall newspaper. If in later years the development of digital technology made it possible to supply the wall newspaper with fresh reportage photographs, then in the 1990s we used sketches and cartoons to illustrate it. «The artist» of the school's wall newspaper in those years was a student of the Department of Electronics Anton Popov. In 1995, among the «counselors», a future employee of the department, and at that time a 4th-year student, Vladimir Titov, also visited the school.

In addition to Saratov and the Saratov region, delegations of schoolchildren from Izhevsk, Nizhny Novgorod, Moscow also regularly came to «Nonlinear Days», in 1993, schoolchildren from Germany attended the school, whom I, then a 3rd-year student, happened to take care of as a «counselor». The age of German schoolchildren coincided with the age of our junior students. Communication with them was not difficult, since some of them studied Russian at school, and the rest — English, which I was quite fluent in conversational level after the English special school. We even managed to involve a team of German schoolchildren in the game «What? Where? When?» by preparing questions specifically for them in German and English. Subsequently, an intellectual game «What? Where? When?» (although in form it was more like a Brain ring) became the highlight of the program of «children's» schools, the participants always looked forward to it.

After a short break in the 1990s, the «children's» school, the favorite brainchild of the Department of Electronics, resumed under a new name — «Nonlinear days in Saratov for young people», associated with a new scientific direction of the department and faculty. The aim of the new schools was to attract talented young people to nonlinear dynamics. The composition of the school's participants has changed. If the first schools were attended exclusively by high school students, now students and postgraduates of both the Faculty of Nonlinear Processes and other faculties of SSU and other universities of Saratov have also become participants. The program of the school included a «conference» part, where graduate students and students, and sometimes schoolchildren, made scientific reports, both oral and poster. According to the results of the schools in the publishing house «Gosunts «College», and then in the RIO journal «Izv. universities. Applied nonlinear dynamics» collections of scientific papers of the school speakers were published.

I have repeatedly been a member of the organizing committee of schools «Non-linear days», already being a teacher of the department. Very fond memories remained from these years, from joint activities together with A., A.Koronovsky, A., E.Khramov, who not only gave lectures for school participants, but also managed to do a lot of work on the organization and information support of schools. Since the number of school participants has increased significantly, it was not always possible to arrange accommodation for all of them in a boarding house. In these cases, a special bus was organized, which delivered participants in the morning and evening from the 8th building of SSU to the school venue. We repeatedly had to go to Saratov for organizational



Fig. 0. Коллектив кафедры электроники, колебаний и волн, 2022. Слева направо: М. И. Перченко, В. Н. Титов, И. С. Ремпен, Е. Н. Егоров, С. В. Гришин, А. С. Бир, В. Н. Скороходов, А. А. Фунтов, М. А. Амельченко, А. В. Титов,

The staff of the Department of Electronics, Oscillations and Waves, 2022. From left to right: M. I. Perchenko, V. N. Titov, I. S. Rempen, E. N. Egorov, S. V. Grishin, A. S. Bir, A. A. Funtov, M. A. Amelchenko, A. V. Titov

materials during the day, then return, hold some planned event with schoolchildren in the evening, and then prepare and print out tasks for the seminar or award certificates for school participants until the middle of the night.

The great merit of the schools is that they created excellent conditions for informal communication between different generations of people of science, gave an impetus to the science of young people. Many of the schoolchildren and students — participants of the first schools — managed not only to graduate from universities, but also to defend candidate and even doctoral dissertations. But they kept the memories of «children's», «electronic» and «nonlinear» schools for life, as well as a warm attitude to nonlinear science and to the organizers of these schools - the staff of the Faculty of Nonlinear Processes and the Department of Electronics, Vibrations and Waves.

Despite all the difficulties of modern times, including the Covid-19 pandemic of 2020–2022, the tradition of "Nonlinear schools for young people" organized by physicists continues. The last of these schools was held in 2021 [4]. At the school, 12 leading scientists from Saratov, Nizhny Novgorod, Moscow and other cities gave their lectures, united by the common cause of studying vibrations and waves, and also presented their reports to almost fifty young participants who, following the results of the school, had the opportunity to publish articles based on their reports in the journal "Izvestiya Vuzov. Applied nonlinear dynamics".

In recent years, the Department of Electronics, Oscillations and Waves, together with microwave electronics and «nonlinear Science», has been going through difficult times again. But the educational and scientific work continues. Active young employees — Associate Professor Alexey Vladimirovich Titov, assistants Alexander Andreevich Pounds, Maria Denisovna Amelchenko, Anastasia Sergeevna Bir — students of Dmitry Ivanovich Trubetskov and Sergey Valeryevich

Grishin — contributed and contribute to the development of the department, raise new scientific problems, solve new problems and, maintaining glorious traditions departments invest their efforts in the training of new young cadres - physicists and «electronics engineers».

The head of the Department of Electronics for almost 40 years, D., I. Trubetskov, our Dmitry Ivanovich, was an excellent lecturer and speaker, he loved poems very much, knew a lot of them by memory and composed himself, and practically none of his solemn speech was complete without poetic lines quoted to the place. I want to support this tradition and finish my story with the lines of A. Dolsky that are close to me.

To solve fate as a problem,
It is not enough to comprehend the basics of the universe,
There is also the formation of the soul —
The highest education.

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