JOURNAL OF PHYSICS AND CHEMISTRY

Review Article

Volume 2 | Issue 3

Their Hearts Beat Coherently

VV Apollonov

Full member of the Academy of Military Sciences, Doctor of Physical and Mathematical Sciences Russia

***Corresponding Author:** VV Apollonov, Full member of the Academy of Military Sciences, Doctor of Physical and Mathematical Sciences Russia.*

Submitted: 09 Feb 2024 **Accepted:** 16 Feb 2024 **Published:** 22 Feb 2024

Citation: *VV Apollonov (2024). Their hearts beat coherently, J of Physics & Chemistry. Review Article 2(3).1-07.*

Abstract

I had the great fortune to study and work in close contact with the outstanding Russian physicists Alexander Mikhailovich Prokhorov and Nikolai Gennadievich Basov. I have never ceased to be amazed at the manifestations of their genius, each time discovering new facets of the many talents of their teachers.

What do I remember first of all when they have been gone for more than 20 years and the acute emotions of parting have long since subsided? Incredibly developed sense of intuition, astonishing in its speed ability to find the right solutions, a keen sense of the new, fundamentally important for a leap into the future, humanity. But the sense of the cutting edge of science, the trends of its development were, perhaps, the main in the character of these phenomenal scientists. My task in this article is to add my own colors to complete the images of these great scientists and citizens of Russia - Alexander Mikhailovich Prokhorov and Nikolai Gennadievich Basov.

Introduction

In 1955, A.M. Prokhorov and N.G. Basov published a scientific report on the "three-level method". It should be noted that the American physicist C.H. Towns of Columbia University was working on a similar idea. It was he who called his creation a maser. A.M. Prokhorov and N.G. Basov called it a molecular generator, based on its physical essence. The physical principle of this device can be explained based on the theory of A. Einstein's theory. The result of his research, in particular, was an equation that described the absorption and emission of radiation by molecules. However, for quite a long time the study of these processes was only an important part of theoretical physics. N.G. Basov and A.M. Prokhorov translated this theoretically predicted radiation into practical terms. They not only managed to amplify this radiation, but on its basis they created a molecular generator - a maser. They were able to increase the number of excited molecules using the electric field of a quadrupole capacitor. The maser generated radiation with a strikingly narrow line in the centimeter wavelength region.

In 1960, a physicist from the company "Hughes Aircraft" (USA) designed a device emitting already in the optical wavelength range and which was also based on the idea of inverse population of levels. T.H. Maimen's device very quickly became widespread. The name of this device was already predetermined - Laser! In 1964, N.G. Basov, A.M. Prokhorov and C.H. Towns were awarded the Nobel Prize. However, the laureates did not stop there. They continued to develop lasers and laser technologies of various types and directions. It should be said that N.G. Basov and A.M. Prokhorov were engaged not only in scientific activities. They were also editors of several scientific journals. They were also members of many academies of sciences in different countries of the globe. The scientific work of the two front men - teacher and student - led to a brilliant discovery, which, and there is no doubt about it, is one of the most important in the 20th century, The wording of the Nobel Committee reads as follows: "For fundamental work in the field of quantum electronics, which has led to the construction of oscillators and amplifiers based on the maser-laser principle." The essence of this grandiose breakthrough made by N.G. Basov and A.M. Prokhorov, which eventually led, in full accordance with the verdict of the Nobel Committee, to the creation of the laser is described in detail in many sources.

In the Nobel lecture A.M. Prokhorov gave a detailed account of the history of quantum electronics, starting with the idea of stimulated emission expressed in 1917 by A. Einstein, its significant advancement in terms of theoretical development of the model of stimulated emission by an excited atom under conditions of interaction with an external field in 1927 by Dirac. Its independent appearance in 1955 in the USSR and in the USA was predetermined by the appearance of the pumping method to create conditions for negative absorption. The fact that it occurred for the first time in the radio band was explained by the significant

development of electron paramagnetic resonance methods by that time. It seemed to scientists that the transition to the optical range would not take long, it turned out not to be so. It took almost 6 years to find an alternative to the resonator of the radio range and an effective method of creating an inverse population, but already in the optical range. Further in A.M. Prokhorov's lecture the possibilities of coherent radiation generation in the X-ray wavelength range were considered. The possibility of building laser systems with smooth frequency tuning of radiation in a wide range was also anticipated. The lecture highlighted important applications of lasers in various fields of science and technology. In particular, he expressed powerful ideas of laser applications in the study of multi-quantum processes, the possibility of creating conditions for ionization and dissociation of molecules under conditions of strong fields. The main goal of the lecture was to study the effects of laser radiation and the realization of the conditions of optical breakdown in matter.

N.G. Basov in his lecture allowed himself to philosophize on the role of theory and experiment, dividing all physicists into two groups. In modern physics, as it may have been before, there are two different currents. One group of physicists sees their goal as the cognition of new regularities and the resolution of existing contradictions. They see their output as theory, in particular the development of the mathematical apparatus of modern physics. New principles of construction of devices and physical apparatus appear as a waste of production. Another group of physicists, on the contrary, strives to create physical instruments based on a new principle, and heading towards this goal, tries to circumvent the inevitably encountered difficulties and contradictions. Various hypotheses and theories are considered by this group as waste products. Both groups have outstanding achievements. One group creates a breeding ground for the other and therefore they cannot live without each other, although their relationship is quite sharp. The former group calls the latter "inventors", the latter accuses the former of being abstract and sometimes aimless.

At first glance, it might seem that we are talking about theorists and experimenters. But it is not: both the first and second groups include both of these varieties of physicists. Nowadays the division into these two groups has become so sharp that whole areas of science can be assigned to the first or second group, although there are sections of physics where both groups work together. The first group of physicists includes most researchers working in quantum field theory, elementary particle theory, many questions of nuclear physics, gravitation, cosmogony, and a number of questions of solid state physics. A striking example of the second group are physicists engaged in the development of fusion, quantum and semiconductor electronics and related fields.

History of n g Basov's Arrival at The Laboratory of Vibrations

Let us return to those years, when the great associate of A.M. Prokhorov, who had gone through the war and received serious wounds, with the consequences of which he agonized all his life, namely, the front-line soldier N.G. Basov began his first steps to the heights of science. Immediately after the end of the war, Nikolay Basov entered MEPhI and, starting from the third year, began working as a laboratory assistant at FIAN. The whole further scientific life of N. Basov was closely intertwined with the life of A.M. Prokhorov and this article unwittingly reflects this continuous connection, starting from the moment when Nikolay Basov, a graduate student, came to A.M. Prokhorov's laboratory. It should be said that Nikolai Gennadievich's path from the beginning of higher education to the scientific breakthrough that brought him the Nobel Prize was exceptionally fast, the fastest for a Soviet physicist. True, the higher education itself had to be delayed: when Nikolai was 19, the Great Patriotic War began. It was at the Kuibyshev Medical Academy that he was trained as a physician's assistant and in 1943 he went to the First Ukrainian Front, reaching Prague with it. Amazingly, both Soviet laser creators went through the most brutal war and yet survived! The head of the laboratory convinced the Director of FIAN, Acad. D.V. Skobeltsyn to introduce one more staff unit in the laboratory for the novice scientist, and for this he promised to provide his synchrotron for research in another scientific direction important for the Institute. At FIAN at that time it was said that A.M. Prokhorov had exchanged the synchrotron for some student, and Alexander Mikhailovich himself joked that N.G. Basov was extremely expensive for him. These were the conditions in which the creative life of an outstanding scientist began! As a matter of fact, the candidate's thesis, defended in 1953, and the subsequent doctoral thesis, defended in 1956, contained the outline of what he and his supervisor were later awarded the Nobel Prize for.

After receiving the Nobel Prize, Academicians N.G. Basov and A.M. Prokhorov lived almost four decades more. Some sources wrote that on their return from Stockholm, the scientists allegedly quarreled over access to the country's military state order. And the division in those years of the Lebedev Physical Institute of the USSR Academy of Sciences into two separate institutes was also, as it were, a consequence of worsened relations. And laser physics in our country allegedly began to develop in two separate and independent branches. But this is far from true! It is just idle speculation and gossip, as many scandal-hungry journalists and scientists without names have sinned and still do. Nevertheless, thanks to this "enmity" Russia became a world leader in laser physics, both in civil and military spheres of activity. In any actively developing field of knowledge, and this is an axiom, competition is necessary for its further development. There is competition in science, even to a greater extent than anywhere else. So, it is reasonable and useful for business competition and was perceived by others as a basis for gossip. As a person who worked in laser physics for more than 50 years, I assert that there was and could be no enmity between these outstanding scientists immersed in science! But there were a few people who wanted to warm themselves at the semblance of a fire kindled by them for career purposes!

Am Prokhorov - Educator of Talents

The Institute of General Physics at the stage of formation was lucky to have a leader. The state of the highest tension in the search for the only true at that moment solutions by the experienced hand of the conductor was replaced by the fun of a successful joke, witticism, anecdote at a scientific seminar. The chief appreciated witty anecdotes and skillfully used key phrases

to the point. If during the seminar you didn't learn something important, it meant that you just didn't understand something, that you were out of shape. Loud laughter from the office, occasionally audible even in remote parts of the corridor, confirmed: everything is fine, we keep moving forward, we live. The ability to find a solution even in an insanely difficult situation, when it is obvious that there is no solution and nowhere to take it - this is also his school. Here it is important, first of all, to think about the case, not about yourself, not to be afraid to make a mistake. A mistake can be corrected, but lost time can never be regained. A good example is a bouquet of decisions from the beginning of perestroika. Here is one of them: at the most difficult moment, when science had just been thrown overboard, it was necessary to quickly comprehend the phrase "everything that is not prohibited by law is allowed". The solution was simple and effective: to give freedom to departments and laboratories, to conduct foreign economic activity on a contractual basis and grants. And this was at a time when neither the accounting nor the planning department simply did not have the specialists to dig through piles of papers in all kinds of imported languages. Scientists with world names, and there were several dozens of them in the Institute, who traveled the world and well understood how the "rotten" with its predominantly contractual form of financing science, quickly got used to it and ensured a smooth transition to new forms of work. It is now, when everyone and everything understands and give advice to others, much seems trivial. But then it was necessary to see an effective way out of the situation and make a decision, which at that time gave a very significant result in terms of the survival of science.

Academician Prokhorov was an outstanding educator of young and not so young talents. In particular, it was the democratic approach in everything and fairness of decisions made by the Teacher. Any employee could count on being listened to and, if necessary, supported. Even my son Kirill, who still works at IOFAN, was often harassed - family ties and past regalia were not taken into account, and every day it was necessary to prove one's rightness.

Someone was always wrong in a dispute, but this is not a reason for labeling, tomorrow it will be the other way around - you have to work and everything will be fine. The usual question: "What's new?" - and immediately with a smile the answer for the interlocutor - "Nothing!". This was the usual form of dialog, useful for starting a conversation for the next day - last night they separated, and this morning there can and should be scientific news. This is where science is done, and it is an ongoing process. In our lives, we spend a lot of time in the laboratory, often missing the mundane details that make up life outside the institute. But there are serious and very serious situations when it seems that there is no solution and help will not come. And here (and it was well known in the scientific world), the best solution is to go to Alexander Mikhailovich. Not only ours, but also from other institutes, knew that he would not refuse, and if there was an opportunity to help, he would definitely help.

Simplicity in communication with others is another distinctive feature of Academician Prokhorov. Respect and always an even tone in communication, without emphasizing the rank of the participants in the conversation. Whether it is a student or a specific well-mannered official of the state apparatus, it does not matter. In his office or in company with him, all this faded into the second and third plan. The only important thing was the level of intellect, which is the eternal essence of civilization development. And what is quite surprising, people in such conditions of communication with each other as if gained new opportunities for self-expression, felt a surge of creative forces, and they liked it themselves.

Here is a case that happened in Japan at a meeting with Mr. Shikaya, the Governor of Tokyo Metropolis. I was fortunate enough to be a participant and witness to that event. The Japanese, who have well studied the visitors from Russia, instructed our delegation for a few minutes about what was considered to be in keeping with centuries-old customs and rules of good manners in their homeland. We could talk about flowers, about nature, about health. All other topics of conversation could be interpreted as inappropriate to the level of good upbringing of the interlocutors. And you should have seen the faces of these grief instructors after a few minutes of conversation between Academician Prokhorov and the governor of Metropolis Mr. Shikaya-san, where the city of Tokyo is a small part. They talked as if they had known each other since childhood and were insanely pleased with the opportunity to socialize. In this life, wasting time talking about flowers and bows simply means not respecting each other. Apparently, this protective form of communication is introduced in Japan in case of visitors from Russia who can only talk about preferential loans and dividends, which, of course, is extremely relevant today.

On the Intuition of a Scientist

Alexander Mikhailovich Prokhorov was a physicist not only by specialty, but, as they say, in essence, and his habits were physically correct. Here is one of them - he liked the room to be warm, well very warm, just Sahara. "And why warm the room with your heat? What is the average temperature of a normal person? 36,6? Here you go!". To sit long in his office was not so easy, heaters stood directly behind the visitor's back and quite close to this very back. Thermodynamic equilibrium for some, and thermal shielding of the boss for others. It is difficult to overestimate the importance of laser in solving problems of medicine and biology. Back at the dawn of the laser revolution, when the excitement of military applications exceeded all possible limits, Academician A.M. Prokhorov began to introduce into the minds of the Institute's staff and various superiors ideas about the effective use of laser methods of treatment of patients and about the use of lasers in biological research.

Laser can be and is actively used in solving military tasks and it is not a secret for a long time. It cuts, melts, reduces mechanical stability of structures, provides transmission of mechanical impulse and provides force mode of defeat of military equipment. That is why the attention of the military was drawn to the prospect of using lasers for military purposes. Alexander Mikhailovich enthusiastically undertook the development of an interest-

ing and important topic, the creation of powerful laser systems. The Institute's budget at that time consisted of only one third of the money coming from the USSR Academy of Sciences, most of it came from industrial enterprises. Their representatives, active and demanding, knocked on the doors of the Institute every day, providing us with new orders for civil and military needs. A great merit in the fact that we were constantly busy and not idle belongs to A.M. Prokhorov. It was he who managed to establish good contacts with both industrialists and the military.

At the very beginning of the "laser path" it was necessary to make a very important decision: to start developing lasers for the so-called forceful defeat or to choose the second direction - functional, when electronics, optical systems and all kinds of trigger effects in the elements of technology were put out of operation. It was necessary to have deep knowledge and the gift of foresight to make the right step. And Alexander Mikhailovich, as time has shown, was right in asserting that we should have developed this very direction at that time. In 1973, Academician A.M. Prokhorov wrote a letter to Marshal Grechko. It said that forceful defeat is unattainable in the next 30-40 years, and therefore it is necessary to develop functional defeat. Unfortunately, the venerable scientist's opinion was not heeded at that time - this decision was not followed by quick financial gains, it was necessary to work painstakingly with much less funding. Alexander Mikhailovich took a very long and persistent time to prove his point, and if we talk about today, 90 percent of modern laser weapons are exclusively functional. And power weapons have not reached the levels of multi-megawatt average power required to solve both strategic tasks and a new class of civilian problems, where high-energy lasers look very promising.

I was lucky to work with Alexander Mikhailovich on very serious problems; he was not afraid to take on the most difficult tasks. His way of thinking was original, he was able to look at a problem in a non-standard way. When working with high-power lasers, there was a need for an effective way to cool the resonator mirrors, which are not perfect - they absorbed enormous power due to a reflection coefficient that was not one hundred percent. The effect, which we first encountered as the output power of lasers increased, showed that further increase in the output power of the device was impossible, since the mirrors at the point where the laser beam fell were locally heated and locally deformed. That is, the beam was reflected not from a flat surface, but from a hump on it. Due to distortions in the resonator, the total laser power fell, and the beam divergence increased. In this situation, no laser weapon (LW) with a range of hundreds of kilometers was out of the question. It was this problem, discovered in our experiments, that became the subject of my PhD thesis. So, I came under the close attention of an academician, who was responsible for the research of physical processes in the creation of LW. The year 1970 became the year of birth of a new discipline - power optics. Alexander Mikhailovich, and he was my supervisor, was interested in the research progress every day and gave very valuable advice. We consistently analyzed a wide range of dielectric solid materials, because polishing metals in the optical workshop next to expensive crystals seemed to be a big misconception. It was then that silicon carbide became the material of choice. Today, this material has become practically the main material for creating ultra-stable optical telescopes and other optical devices. But silicon carbide did not solve the problem of optical stability of mirrors, it improved it in comparison with quartz and sital, but did not solve it. The prospect of transition to highly thermally conductive but hard metals also did not lead us to the solution of the problem of multi-megawatt lasers, about which politicians and journalists were already talking [1].

It was necessary to make the next step, it was not possible to solve the problem of stable laser mirrors just by choosing a material. It was necessary to attract very efficient cooling. And here again we faced a big contradiction: huge heat flows from the mirror surface with the help of heat carrier in the known at that time physico-technical models could be removed only at high temperature. At the same time, a system of coarse cooling channels was not compatible with an ultra-precise mirror surface whose details were measured in nanometers. As a result of the research, and it had to be very fast and efficient, much became clear in the problem of power optics of high-energy LW. In power optics, these channels had to be very thin, and there had to be a lot of water, and its temperature could not exceed a few tens of degrees. But liquid could not be forced in large quantities through thin channels at low pressure, and besides, when the magnitude of the flow increased, there were vibrations that distorted the surface. Alexander Mikhailovich supported my idea about possible similarity of the mirror cooling system to the human circulatory system, in which hundreds of smaller, even smaller, etc. capillaries branch off successively from a large blood flow main to reassemble into a single macrochannel. And all this has to happen in the mirror on a scale of a few millimeters into the depth of the mirror. Fifteen years of testing of the physical model of the high-energy laser mirror, development of structural models and technologies were successful, and the final goal was realized. Our team was awarded the USSR State Prize in 1982 for the cycle of works in the field of power optics [2-4].

The Americans worked on the problem of resonator cooling in parallel with us. As a result, they solved it in much the same way. When fraternization with the States began in the 90s, I received an invitation to visit the firms that were engaged in power optics at that time and was convinced that the achieved parameters of the mirrors were very close, and the design features of these mirrors were similar. So far, this technology is not sold on the international market, because any country can immediately reach megawatt capacity levels, which means it will have access to LO creation. The mirrors that are sold are only suitable for technological lasers, they are mirrors for small power levels compared to the power levels of military LW complexes.

More Powerful, Even More Powerful

My scientific team was fortunate to solve under the guidance of Alexander Mikhailovich the problem of creating a super-power pulsed CO2 laser. This problem was initially handled by NPO Astrophysics. It was required to create an air defense complex based on a powerful pulsed laser with energy in a pulse of about

30 kJ. Unfortunately, the solution to this problem was beyond the first developers. They failed to solve the problem of pumping the active medium with powerful electron beams in the mode of non-self-discharge. Alexander Mikhailovich proposed to the Ministry of Defense Industry to transfer the work to our team and apply the pumping methods developed by us. The proposal was accepted. Here, too, Alexander Mikhailovich's instincts became apparent; he quickly realized that our method was scalable and suitable for large apertures, and thus for practical application. In 1983, the Americans announced the beginning of a long-term SOI program and an international symposium in Las Vegas to discuss this program. Academicians Prokhorov and Basov were invited as participants. This was a difficult political moment - their presence at the event would give much more prominence to the U.S. program. And in the Defense Department of the CPSU Central Committee, where such issues were decided at that time, it was suggested "not to go". But since we wanted to understand what was going on, we decided to send two young scientists. A call went out in the laboratory, and I was told to be at Staraya Ploshchad in an hour. The next day we flew to the United States. My colleague was absolutely delighted with the goals and objectives of the American program, he understood that if you deploy such a program in the USSR, then in science will go a lot of money, orders from the defense industry, and therefore positively assessed all that was happening in the United States. My assessment was negative. When I came with my report to Alexander Mikhailovich, he frankly said.

"What a fool. "You're absolutely right, though. You won't be understood, you'll be an outcast." And indeed, my colleagues recognized the report as positive, a laser arms race began, and my report was put under the table. By the way, before my trip to Las Vegas, I had just returned from a six-month internship in Canada. At that time, such a trip was tantamount to a miracle; most young scientists could not even dream about it. Alexander Mikhailovich, as well as the second Nobel laureate Nikolai Gennadievich Basov, spent a lot of effort to send their employees to the West for internships after the defense of their PhD theses. When Alexander Mikhailovich called me to him, he liked to start a conversation about the internship with a joke: "Tell me, how do you feel about good sausage and Bavarian sausages?". Traveling abroad provided a tremendous opportunity to compare one's achievements with what had been done in the world, to integrate more tightly into the global scientific environment, and to learn the language effectively. And when perestroika began and hard times came for science, it was those people who had a good command of the language and connections abroad who began to find international contracts... We had several dozens of such scientists in the Institute, it was they who "fed" IOFAN in hard times, we formed several dozen joint-stock companies. Alexander Mikhailovich had the wisdom to let go of the bureaucratic reins and allow scientists to work freely. Or maybe he simply foresaw all this.

Our Calibr

The democratic nature of Alexander Mikhailovich's character was already evident at our first acquaintance. In 1970, I was graduating from MEPhI, working on my diploma in the department of Mikhail Dmitrievich Millionshchikov, Vice-President of the Academy of Sciences. The task was very interesting: we were trying to use a powerful pulsed solid-state laser to produce multicharged ions of very high chargeability. I must give credit here to Igor Mikhailovich Buzhinsky, the chief technologist of the Lorraine Optical Glass Plant, who provided me with new active rods made of glass with neodymium ions that had just come out of production. In the country he was the developer of this material and ensured the success of many scientific developments in the country. But having started these interesting works and counting on their continuation, for certain reasons (the son of a high-ranking official claimed the results of research and a place in graduate school) I could not stay at MEPhI. According to the logic of events, after defending my diploma, I had to go to the laboratory of Academician N.G. Basov. He gave lectures and seminars, and a lot of teachers in the institute were from his scientific team. But conversations with Academician M.D. Millionshchikov encouraged me to go to another Nobel laureate, Alexander Mikhailovich Prokhorov. I was very embarrassed: "How can I go, I don't have even the slightest experience of communicating with him? Finally, I decided to call him. Alexander Mikhailovich listened attentively, asked me about the subject of my work and invited me to talk to him in the Soviet Mecca of laser physics at that time - FIAN. We talked about the results of my thesis work related to the use of high-power lasers for the generation of multicharged ions from laser plasma. In my first independent scientific work, heavy metal ions with charges up to +30 were produced for the first time. But in this case, he said, we will get a simple and efficient source of multicharged ions. And if earlier on gas pedals accelerated to high energies protons, then when working with multi-charged ions immediately many times could increase the energy of the accelerated particle. This would make it possible to make an important step in obtaining relativistic beams of heavy ions. The first experiments in this direction were carried out in Dubna together with Academician Flerov. Today we know about similar experiments with multicharge ion accumulators at CERN.

Having examined me from all sides, he said: "Our caliber." The fact is that I have been tall since childhood and have always been embarrassed by it. Many employees of the Laboratory of Vibrations at FIAN were two meters tall, just like Alexander Mikhailovich. This fact was the subject of many jokes and even anecdotes.

Friendship of Academicians - Friendship of Laboratories

The Laboratories of Fluctuations and Quantum Radiophysics of FIAN conducted a lot of scientific research in the interests of industry and defense complex of the country. Due to this the real budget of the laboratories increased many times in comparison with others, living on purely academic money. By the will of fate I happened to be in the thick of events related to the creation of high-energy lasers. That is why meetings with N.G. Basov became more frequent. Often on behalf of A.M. Prokhorov I had to take part in discussions of scientific and technical issues at meetings of various councils on development, creation and ap-

plication of high-power and high-energy lasers in industry and defense. The point is that I was fortunate to be able, together with A.M. Prokhorov and A.I. Barchukov, to formulate the fundamentals of the Power Static and Adaptive Optics, which we discovered, without which no high-power laser can work.

We in Russia were the first who, thanks to efficient cooling taken from power optics technology, reached the level of 100 W from a single line. That is exactly what N.G. Basov and his collaborators did not have when they created the first disk laser and pumping of the disk had to be done using another laser with the appropriate wavelength. This caused smiles and even irony among many famous scientists of FIAN. But that is the greatness of the great ones that they see much further than their contemporaries and create the future with every step they take. Today the disk laser is the only candidate that allows the creation of strategic laser complexes with minimal weights and dimensions!

The special importance in the relations of laboratory staff was manifested at International Conferences, when help and support were especially valuable. In the 90s, which were very fruitful for laser forums in the USA and Japan, I was lucky to participate in the International Conference on modern high-power lasers and their applications, organized by the Japanese School of Laser Physics. The work of the International Conference was headed by Acad. N.G. Basov, A.M. Prokhorov, and C.H. Towns. A.M. Prokhorov could not come due to his heavy workload at the Academy of Sciences. C.H. Towns came and, as always, was very active in terms of questions to the speakers. I had to make several joint reports with A.M. Prokhorov and me. But I also had to take part in the meeting of the Presidium of the Academy of Sciences of Japan together with the Nobel laureate instead of my chief, which was a great honor for me. N.G. Basov was at the Forum with his wife Kseniya Tikhonovna and went to the meeting together with her. And then there was a mishap with Kseniya Tikhonovna, she apologized to her star husband for a long time and was simply not allowed to attend the meeting. The fact is that up to the end of the XX-th century, all full members of the Academy were male, which is reflected in detail in fiction. Only recently, the first and only woman - Professor of Social Anthropology Tie Nakane - was elected to the Academy. The Basov family respected the tradition of the Academy of Sciences of Japan and Ksenia Tikhonovna left for the hotel, and Nikolai Gennadievich, as if nothing had happened, went to the meeting with a smile. It is possible that this incident, too, influenced the acceleration of changes in the gender predilections of the Academy of Sciences of Japan.

Ng Basov and his Creations

For the first time our team had to turn to the remarkable ideas of Acad. N.G. Basov during the search for new modes of high energy laser radiation impact on a solid body. Low-frequency modes of radiation generation with long pulse durations, characteristic of the late 70s, suffered from a number of negative manifestations. On the other hand, traditional schemes for producing pulse-periodic (I-P) radiation resulted in huge weight characteristics and bulky. Our choice fell on the regenerative mode of amplification proposed by N.G. Basov and his colleagues in 1965, in which a low-energy signal with a duration of several tens of nanoseconds was extracted from the starting radiation of a high-energy laser module and in the regeneration mode was transformed into a sequence of pulses or into a sequence of pulse bursts with adjustable repetition rate. The peak power of individual pulses exceeded the power value of the injected primary pulse by tens and hundreds of thousands of times. The leading specialists in the field of creation of high-power high-frequency high-energy I-P lasers and the authors of the patent were employees of the Institute of General Physics of the Russian Academy of Sciences, who worked under the guidance of Acad. A.M. Prokhorov, We proposed and experimentally realized a laser engine based on this mode on the mechanism of high-frequency optical pulsating discharge and obtained record thrust characteristics of the engine. With the help of high-frequency P-P laser for the first time an intensive and frequency-variable sound in the far zone was obtained, a conducting channel with minimum resistivity was experimentally realized, the possibility of its scaling up to considerable distances and the reality of such a highly conducting channel in air medium and in vacuum were shown [5].

Academician N.G. Basov together with Y.M. Popov and B.M. Vul proposed the idea of creating various types of semiconductor lasers, which today are the main means of pumping modern solid-state lasers. Of particular interest are the studies of Acad. N.G. Basov in our time are related to the emergence of fiber and disk laser systems, which determine the movement towards high energy lasers in minimum dimensions and at minimum weights. It was in the case of creation of the first laser on disk geometry of the active body proposed by N.G.Basov that this type of effective pumping was lacking. Pumping was carried out with another laser, which caused smiles of contemporaries. However, with the appearance of laser diodes and laser diode arrays, everything fell into place. Thus, in 1962, N.G. Basov proposed the idea of creating an injection laser, then lasers excited by electron beams were created, and in 1964 semiconductor lasers with optical pumping were created. N.G. Basov also developed research on high-power gas and chemical lasers. His laboratory developed fluorohydrogen and iodine lasers, an excimer laser, and adder-converters of laser radiation. A number of works by N.G. Basov were devoted to the issues of propagation and interaction of powerful laser pulses with matter. He was responsible for the idea of using lasers to control thermonuclear fusion (1962); he also proposed methods of laser heating of plasma and stimulation of chemical reactions by laser radiation. N.G. Basov and his collaborators also developed the physical basis for the creation of quantum frequency standards, put forward ideas for new applications of lasers in optoelectronics to create optical logic elements, and initiated many studies on nonlinear optics.
N.G. Basov's genius was also involved in the "modern" and still promising solid-state disk laser with semiconductor pumping. This idea of Acad. It is true that this idea of Acad. N.G. Basov is already 60 years old, but this very principle of construction of high-power laser complexes turns out to be dominant today and will remain dominant for a long time in the future. With

References

1. V V Apollonov, A I Barchukov, A M Prokhorov (1972) Letters to JETP 15.
2. V V Apollonov (1985) Letters to JTP 11: 1262.
3. V.V. Apollonov (2000) Quantum Electronics 30: 207.
4. V V Apollonov, A M Prokhorov, A H Guenther (2003) _ Laser Focus World 101.
5. V V Apollonov (2014) High power P-P lasers. New York: NOVA.
6. V V Apollonov (2016) High power lasers in our life. Nova.
7. V V Apollonov (2016) High-Energy Molecular Lasers. Springer Series in Optical Sciences 275. https://www.penguinbookshop.com/book/9783319362960
8. V V Apollonov (2018) High-conductivity channel in space, Berlin: SPRINGER.