Nikolai BASOV

Nikolai Gennadievich

Basov

To the Centenary of the birth

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(revised and corrected), To the Centenary of the birth»
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This book-album (biography in photographs) is dedicated to the Centenary of the birth of the Nobel Prize Winner Academician Nikolai Gennadievich Basov, whose discovery led to the development of a new science – quantum electronics (laser physics) and radically changed our world.

The authors express their deep gratitude to Kseniya Tikhonovna Basova, the widow of N. G. Basov, Archive of the Russian Academy of Sciences for providing photographs and documents.

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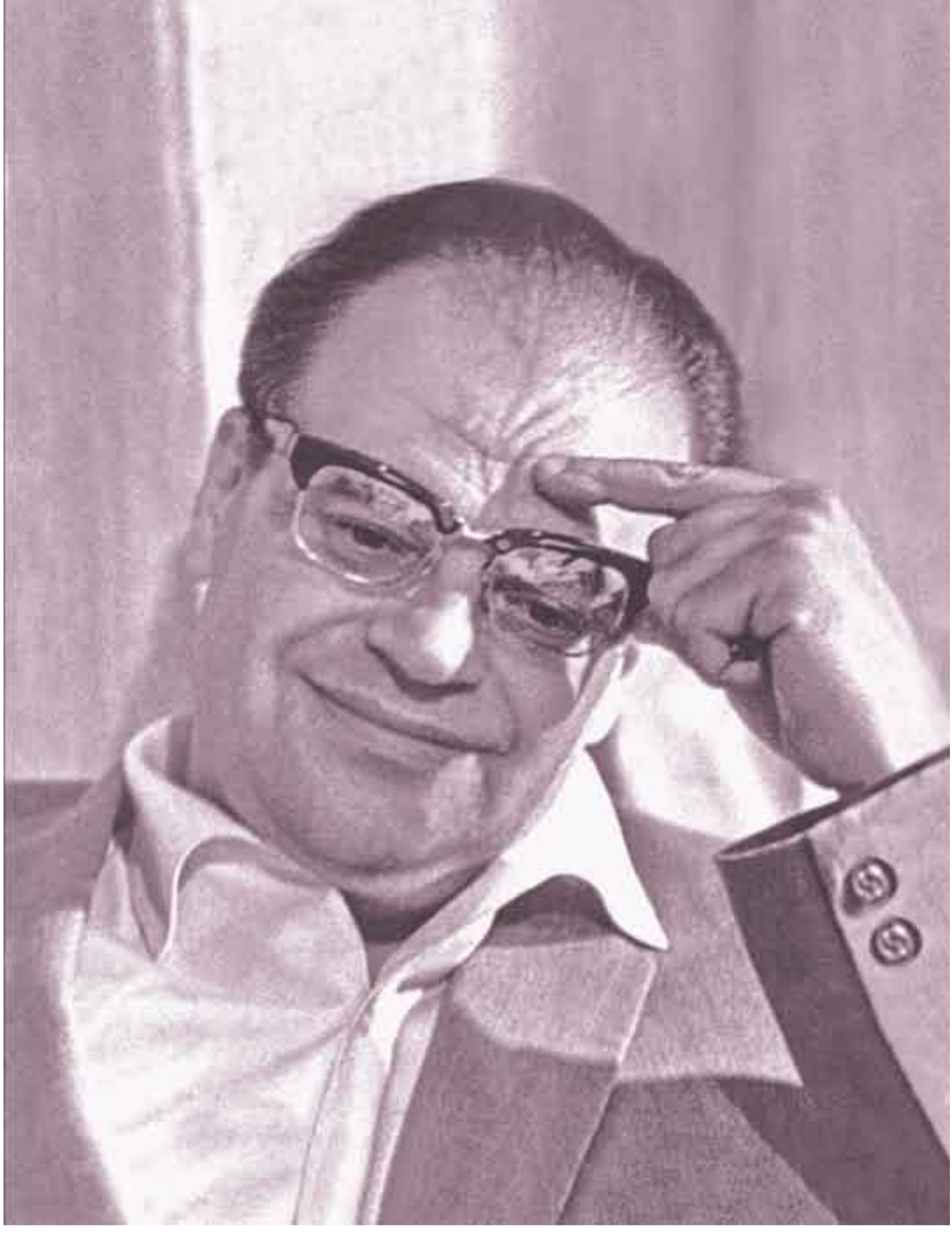


It was typical for N. G. Basov to comprehend the physical picture of phenomena before making the experiment, which allowed him to go, as a rule, the shortest path to the goal. *(V. L. Ginzburg)*

Knowledge and the ability to use it is our main wealth. We improve and rebuild our life, fill it with new content based on this knowledge. But the acquisition of knowledge is a complex multifaceted process that requires hard work and bold creative thought. Science, like art, does not tolerate dullness, falsehood, and indifference. *(N. G. Basov)*

ПРЕДИСЛОВИЕ КО ВТОРОМУ ИЗДАНИЮ

14 декабря 2022 года исполняется 100 лет со дня рождения выдающегося российского физика и организатора науки, лауреата Нобелевской премии по физике, Ленинской и Государственной премий СССР, дважды Героя Социалистического Труда, академика Николая Геннадиевича Басова.

Н. Г. Басов является одним из основоположников новой науки – квантовой электроники, развитие которой привело к созданию лазеров и, по существу, к инициированию новой научно-технической революции, сопоставимой по масштабу с промышленной революцией 18–19-х веков, инициированной созданием парового двигателя, и с технологической революцией XX века, связанной с применением электрической и ядерной энергии и созданием транзистора. Именно создание лазеров и передача громадного количества информации при помощи электромагнитных волн оптического диапазона по оптическим волокнам привело к созданию глобальной информационной сети – интернета.

Главным в научной деятельности Н. Г. Басова было создание и развитие новых перспективных научных, технических и технологических направлений – таких как физика лазеров, лазерный термоядерный синтез, стандарты частоты и атомные часы, лазерная локация Луны, разработка лазеров для промышленности и медицины, лазерная противоракетная оборона и др. – и одновременно проведение исследований в уже созданных направлениях для обеспечения решения крупных и конкретных задач науки, техники и обороны.

В 36 лет Николай Геннадиевич стал заместителем директора Физического института имени П. Н. Лебедева РАН (ФИАН), а позже возглавлял его на протяжении 15 лет, развивая не только квантовую электронику – лазерную физику, но и все направления научной деятельности ФИАНа: ядерную физику и физику плазмы, физику полупроводников, оптические исследования, радиоастрономию, физику плазмы и ускорителей, физику Солнца и космического пространства и др.

PREFACE TO THE SECOND EDITION

December 14, 2022 marks the Centenary of the birth of the outstanding Russian physicist and organizer of science, Nobel Prize Winner in Physics, the Lenin and State Prizes of the USSR, twice Hero of Socialist Labor, Academician Nikolai Gennadievich Basov. N. G. Basov is one of the founders of a new science – quantum electronics, the progress of which resulted in the development of lasers and, in essence, to the initiation of a new scientific and technological revolution, comparable in scale to the industrial revolution of the 18-19th centuries, initiated by the development of a steam engine, and to the technological revolution of the XXth century, associated with the use of electrical and nuclear energy and the development of a transistor. It was just the development of lasers and the transmission of a huge amount of information by laser radiation through optical fibers that resulted in the development of a global information network – the Internet.

The main thing in the scientific activity of N. G. Basov was the development of new promising scientific, technical and technological areas – such as laser physics, laser thermonuclear fusion, frequency standards and atomic clocks, laser ranging of the Moon, the development of lasers for industry and medicine, laser missile defense, etc. – and at the same time carrying out research in already established areas to ensure the solution of important and specific problems of science, technology and defense.

At the age of 36, Nikolai Gennadievich became deputy director of the P. N. Lebedev Physical Institute of the USSR Academy of Sciences (acronym FIAN in Russian), and later headed it for 15 years, developing not only quantum electronics – laser physics, but also all areas of scientific activity of FIAN: nuclear physics and plasma physics, semiconductor physics, optical research, radio astronomy, plasma and accelerator physics, solar and outer space physics, etc.

He was the inspirer of foundation of the Special Design Bureau in the Krasnaya Pakhra village (now the town of Troitsk (New Moscow)), in which many experimental installations were

Он был вдохновителем создания Особого конструкторского бюро в пос. Красная Пахра (ныне г. Троицк (Новая Москва)), в котором были созданы многие экспериментальные установки; Крымской научной станции в пос. Кацивели, где проводились исследования в области лазерной локации Луны; создал Высшую школу физиков в его «Альма-матер» – Московском инженерно-физическом институте, куда приглашали талантливых студентов со всего СССР, а позже – России, продолжить обучение и стать профессиональным физиком; инициировал создание филиала ФИАН в г. Куйбышев (ныне г. Самара) – кластере предприятий аэрокосмической промышленности, – для внедрения в эту промышленность технологических лазеров.

Почти 60 лет назад, в 1963 году Н. Г. Басов создал и возглавил лабораторию Квантовой радиофизики, выросшую за это время и преобразованную с начала 90-х годов в Отделение квантовой радиофизики (ОКРФ) ФИАН и носящую с 2001 г. имя Николая Геннадиевича: Отделение квантовой радиофизики имени Н. Г. Басова ФИАН. Основными направлениями научных исследований ОКРФ являются: физика лазеров, новые типы лазеров, лазеры ультракоротких импульсов, взаимодействие лазерного излучения с веществом, нелинейная оптика, физика плазмы, лазерный термоядерный синтез, оптоэлектроника, лазерная технология, рентгеновская оптика, нанофотоника, применение лазеров в науке, технике и биомедицине. Около двух лет назад в ОКРФ был создан Центр лазерных и нелинейно-оптических технологий, в который, в частности, вошли новые лаборатории: лаборатория фемтосекундной нелинейной оптики и лаборатория лазерной нанофизики и биомедицины.

Автор этих строк пришел в научную структуру ФИАН, которая сейчас называется ОКРФ имени Н. Г. Басова, более 50 лет назад и хорошо помнит, с каким энтузиазмом и с какой самоотверженностью работали и продолжают работать сотрудники ОКРФ, не считаясь со временем, как внедрялись научные результаты в промышленность, какие впечатляющие результаты давали исследования на полигонах. Полагаю, что именно заложенный много лет назад Николаем Геннадиевичем импульс развития ОКРФ позволяет сейчас Отделению квантовой радиофизики имени Н. Г. Басова успешно развиваться.

Настоящая книга-альбом, посвященная 100-летию со дня рождения Н. Г. Басова, является вторым исправленным и дополненным изданием книги-альбома, выпущенного

designed and constructed; of the Crimean scientific station in the Katsiveli village, where research was carried out in the field of laser location of the Moon; he founded the Higher School of Physicists at his Alma Mater, the Moscow Engineering Physics Institute (now the Nuclear University MEPhI), where they invited talented students from all over the USSR, and later from Russia, to continue their education and become a professional physicist; initiated the foundation of FIAN branch in the city of Kuibyshev (now the city of Samara) – a cluster of enterprises of the aerospace industry – to introduce technological lasers into this industry.

Almost 60 years ago, in 1963 N. G. Basov founded and headed the Quantum Radiophysics Laboratory that was growing since that time and was transformed from the beginning of the 90s into the Quantum Radiophysics Division (QRPD) that has been bearing the name of Nikolai Gennadievich since 2001: N. G. Basov Quantum Radiophysics Division of FIAN. The main areas of scientific research of the QRPD are as follows: laser physics, new types of lasers, ultrashort pulse lasers, interaction of laser radiation with matter, nonlinear optics, plasma physics, laser thermonuclear fusion, optoelectronics, laser technology, X-ray optics, nano-photonics, the use of lasers in science, technology and biomedicine. About two years ago, the Center for Laser and Nonlinear Optical Technologies was established at QRPD, which, in particular, included new laboratories: the Laboratory of Femtosecond Nonlinear Optics and the Laboratory of Laser Nanophysics and Biomedicine.

The author of these lines came to the scientific structure of the P. N. Lebedev Physical Institute that is now called the N. G. Basov Quantum Radiophysics Division, more than 50 years ago and remembers well the enthusiasm and dedication with which the employees of the QRPD worked and continue to work, regardless of the time, how the scientific results were implemented in the industry, what impressive results were obtained by research at the test sites. I believe that it was just the impetus for the development of the QRPD laid many years ago by Nikolai Gennadievich, that now allows the N. G. Basov Quantum Radiophysics Division to successfully develop laser science.

This book-album dedicated to the Centenary of N. G. Basov's birth is the corrected and supplemented second edition of the book-album, released in 2017 for the 95th anniversary of Nikolai Gennadievich's birth. Many thanks to

к 95-летию Николая Геннадиевича в 2017 году. Большое спасибо Ксении Тихоновне Басовой, В. В. Аполлонову, А. В. Виноградову, А. В. Масалову и Н. А. Михайлову, предоставившим дополнительные материалы.

Многие зарубежные коллеги, которым дарили первое издание книги-альбома, выражали свою искреннюю благодарность, но в то же время и сожаление, что он был издан не на английском языке. В связи с этим, второе издание выпускается как на русском, так и на английском языке.

Профессор А. А. Ионин,
руководитель Отделения квантовой радиофизики имени Н. Г. Басова ФИАН,
почётный член (Fellow) Международных научных обществ SPIE и Optica (ранее OSA).

ПРЕДИСЛОВИЕ К ПЕРВОМУ ИЗДАНИЮ

Басов Николай Геннадиевич (14.12.1922–01.07.2001) – выдающийся российский физик и организатор науки, один из основоположников квантовой электроники, академик РАН (1966), член Президиума АН СССР (1967–1990), директор Физического института имени П. Н. Лебедева РАН (ФИАН) (1973–1989), руководитель Отделения квантовой радиофизики ФИАН (1989–2001) (ныне имени Н. Г. Басова), профессор Московского инженерно-физического института (МИФИ, ныне НИЯУ МИФИ), заведующий кафедрой квантовой электроники МИФИ, научный руководитель Высшей школы физиков МИФИ – ФИАН (ныне имени Н. Г. Басова), председатель правления Всесоюзного общества «Знание», главный редактор журнала «Природа» (1967–1990), член Президиума Верховного Совета СССР (1982–1989), член Советского Комитета защиты мира и член Всемирного Совета Мира (1965–2001).

Его фундаментальные исследования в области квантовой электроники получили мировое признание и отмечены рядом высших научных наград: лауреат Нобелевской (1964), Ленинской (1959) и Государственной премий (1989); дважды Герой Социалистического Труда (1969, 1982); награждён пятью орденами Ленина, орденом «За заслуги перед Отечеством» II степени (1999), медалью РАН им. М. В. Ломоносова (1990) и рядом зарубежных медалей – Золотой медалью им. А. Вольты Университета в Павии (Италия) (1977), медалью Университета Сорбонны (1983), Большой золотой медалью

N. G. Basov's widow Kseniya Tikhonovna Basova, V. V. Apollonov, A. V. Vinogradov, A. V. Masalov and N. A. Mikhailov who provided additional materials.

Many foreign colleagues who were presented with the first edition of the book-album expressed their sincere gratitude, but at the same time regretted that it was not published in English. For this reason, this second edition is published both in Russian and in English.

Professor Andrey A. Ionin,
Head of the N. G. Basov Quantum Radiophysics Division of the P. N. Lebedev Physical Institute,
Fellow of the International Scientific Societies SPIE and Optica (former OSA).

PREFACE TO THE FIRST EDITION

Basov Nikolai Gennadievich (14.12.1922–01.07.2001) is an outstanding Russian physicist and organizer of science, one of the founders of quantum electronics; academician of the Russian Academy of Sciences (RAS) (1966); member of the Praesidium of the USSR Academy of Sciences (1967–1990); director of P. N. Lebedev Physical Institute (FIAN) (1973–1989); head of the Quantum Radiophysics Division of the FIAN (1989–2001) (now named after N. G. Basov); professor of Moscow Engineering Physics Institute (MEPhI, now Nat. Res. Nucl. Univ. «MEPhI»); head of the chair of quantum electronics of MEPhI; scientific director of the Higher School of Physicists MEPhI–FIAN (now named after N. G. Basov); chairman of the board of the All-Union Society «Znanie» *(«Knowledge» in English – ed. remark)*; editor-in-chief of the journal «Priroda» (Nature) (1967–1990); member: Praesidium of the Supreme Soviet of the USSR (1982–1989), Soviet Peace Committee, World Peace Council (1965–2001).

The fundamental investigations of N. G. Basov in the field of quantum electronics have received world recognition and were marked by the highest scientific awards: the Nobel Prize in physics (1964); Lenin (1959) and State Prizes (1989); twice Hero of Socialist Labor (1969, 1982); five Orders of Lenin; the Order of «Merit for the Motherland» II degree (1999); the M. V. Lomonosov medal of the RAS (1990); the A. Volta gold medal of the University of Pavia (Italy) (1977); the Sorbonne University medal (1983); the grand gold medal of Paris (1983), the Ministry of Culture medal of France (1983); the Commandor Cross of the «Merit» Order (Poland) (1986); E. Henkel «Urania» society gold medal

Парижа (1983), медалью Министерства культуры Франции (1983), Командорским крестом ордена «Заслуги» (Польша) (1986), Золотой медалью им. Э. Генкеля общества «Урания» (1986), премией Калинги (ЮНЕСКО) (1986), медалью Эдварда Теллера (1991).

Он был членом Академии наук Болгарии, Швеции (IVA), Чехословакии, Польши, Индии; членом Американского оптического и физического обществ, Общества Марка Твена США, почётным доктором ряда зарубежных университетов.

Николай Геннадиевич Басов родился 14 декабря 1922 года в небольшом российском город Усмани Тамбовской губернии (ныне Липецкая область). В последние годы его учёбы в школе Советский Союз вступил во Вторую мировую войну, и он служил в армии в качестве студента Военно-медицинской академии (1941–1943) и офицера батальона химической защиты на Первом Украинском фронте (1944–1945). В 1946 году он поступил в Московский инженерно-физический институт и окончил его в 1950 году по специальности «инженер-физик». Н. Г. Басов подготовил кандидатскую диссертацию в 1953 году под руководством М. А. Леонтовича и А. М. Прохорова и получил степень кандидата наук в Физическом институте им. П. Н. Лебедева. В конце концов он, начав работать младшим научным сотрудником, был избран директором института и проработал в нём до последнего дня своей жизни.

В 1952 году Басов и Прохоров на основе теоретического анализа первыми продемонстрировали возможность построения генераторов и усилителей электромагнитных волн с использованием явления вынужденного перехода в квантовых системах с инверсией населённости уровней. В 1955 году они предложили высокоэффективный принцип достижения инверсии путём СВЧ-накачки трёхуровневой системы – технология, которая теперь широко используется в различных лазерах и спектральных диапазонах.

В 1956 году Басов защитил докторскую диссертацию «Молекулярный генератор».

Диссертация была заметным достижением, фундаментальные находки Басова были блестящими и новыми, в качестве рецензентов были приглашены наиболее авторитетные учёные.

В 1964 году Н. Г. Басов, А. М. Прохоров и Ч. Таунс получили Нобелевскую премию по физике за фундаментальные исследования в области квантовой электроники, которые привели к открытию мазеров и лазеров.

(1986), the Kalinga Prize (UNESCO) (1986), the Edward Teller medal (1991).

He was the member of the Academies of Sciences of Bulgaria, Sweden (IVA), Czechoslovakia, Poland, India; member of the American Optical and Physical Societies, Mark Twain Society (USA), honorary doctor of a number of foreign universities.

Nikolai Gennadievich Basov was born on December 14, 1922 in Usman, a small Russian town in the Tambov province (now the Lipetsk region).

During his last years at school, the Soviet Union entered World War II, and he served in the army as a student of the Military Medical Academy (1941–43) and as an officer of the chemical defense battalion of the First Ukrainian Front (1944–45).

In 1946, he entered the Moscow Engineering Physics Institute and graduated in 1950 as the engineer-physicist.

He completed his PhD thesis in 1953 under the guidance of M. A. Leontovich and A. M. Prokhorov and received his Candidate of Science degree from P. N. Lebedev Physical Institute. He eventually worked his way up from a junior scientist to the director of the Lebedev Institute, maintaining an affiliation until the last day of his life.

Basing on a theoretical analysis, Basov and Prokhorov were the first to demonstrate in 1952 the feasibility of constructing oscillators and amplifiers of electromagnetic waves by using the phenomenon of stimulated transition in quantum systems with population inversion. As early as 1955, they proposed a highly effective principle for achieving population inversion by microwave pumping a three-level system, the technique that is now widely used in various lasers and spectral ranges.

In 1956, Basov received his DSc degree for his thesis entitled «A Molecular Oscillator». The thesis was a notable accomplishment, his fundamental findings were so brilliant and unexpected that the most authoritative scientists were invited as reviewers.

In 1964, N. G. Basov, A. M. Prokhorov, and Ch. Townes won the Nobel Prize in Physics for the fundamental research in the field of quantum electronics, which led to the discovery of masers and lasers.

Nikolay Gennadievich Basov was an outstanding personality who generated around him an atmosphere of creativity, obsession with science, and high human relations. They say that such people are the donors – so much they influence the surrounding people, as if passing them their inexhaustible energy and particles of their talent.

Николай Геннадиевич Басов был выдающейся личностью, порождавшей вокруг себя атмосферу творчества, одержимости и высоких человеческих отношений. О таких людях говорят, что они являются донорами – столь сильно они воздействуют на окружающих, как бы передавая им свою неисчерпаемую энергию и частицы своего таланта. Так воспринимали Николая Геннадиевича не только его сотрудники – я много раз был свидетелем того, что его выступления вызывали повышенное внимание в «верхах». Николай Геннадиевич сделал чрезвычайно много в области, которой он посвятил свою жизнь. Я беру на себя смелость утверждать, что если бы существовал рейтинг Нобелевских премий, то премия «За фундаментальные исследования, приведшие к созданию мазеров и лазеров», полученная им в 1964 г. Вместе с А. М. Прохоровым и Ч. Таунсом, заняла бы одно из первых мест. Действительно, вклад квантовой электроники в современную цивилизацию исключительно высок и сопоставим с открытиями рентгеновских лучей, ядерной энергии, радио, транзисторов.

В науке Н. Г. Басов был исключительно цельной натурой, он был предан своему делу и своему институту, был свято уверен в необходимости как можно быстрее реализовывать результаты научных исследований на благо страны.

Именно в этом духе он и построил свою жизнь и научную работу, именно таким знали Николая Геннадиевича в родном для него Физическом институте им. П. Н. Лебедева, который он очень любил и возглавлял с 1973 по 1989 г., сменив на этом посту директора Д. В. Скобельцына.

Квантовая радиофизика, или, может быть, более точно – лазерная физика, была предметом постоянного увлечения Николая Геннадиевича, и это знали все его коллеги и сотрудники. Ещё примерно 40 лет назад, когда только появились лазеры, Николай Геннадиевич предсказал чуть ли не новую научно-техническую революцию, связанную с этим открытием. Многим тогда казалось, что это слишком большое преувеличение. Однако именно сейчас происходит интенсивное проникновение лазеров в современную технологию – от использования их в эндоскопических и глазных операциях до трансконтинентальных линий связи, от сверхточных измерений до компакт-дисков и лазерных принтеров. Очевидно, что такой большой срок – 35–40 лет, которые потребовались для начала бурного практического

This is how Nikolai Gennadievich was perceived not only by his colleagues – I was many times a witness of his speeches causing increased attention in the «higher echelons of power». Nikolai Gennadievich had done extremely much in the area, to which he devoted his life. I take the liberty of saying that, if there existed a rating of Nobel Prizes, the prize «For the fundamental research that led to the creation of masers and lasers», won in 1964 by Basov, Prokhorov, and Townes, would take one of the first places. Indeed, the contribution of quantum electronics to modern civilization is exceptionally high, and may be compared to the discoveries of X-rays, nuclear energy, radio, transistors.

In science, N. G. Basov was a whole-hearted solid person, he was entirely devoted to his work and his institute, and was firmly convinced of the need to implement, as soon as possible, the results of scientific research for the benefit of his country.

It was just in this way he built his life and scientific work. And that is how he was known at his own institute, which he loved very much and was heading it from 1973 to 1989, succeeding academician D. V. Skobeltsyn.

Quantum radiophysics, or, perhaps more accurately, laser physics, was the object of constant enthusiasm for Nikolai Gennadievich, and all his colleagues and employees knew that.

About 40 years ago, when the lasers just appeared, Nikolai Gennadievich predicted almost a new scientific and technological revolution connected with this discovery.

Many of his colleagues then thought it was too much an exaggeration. However, right now, the intensive penetration of lasers into modern technology takes place: from their use in endoscopic and eye operations to trans-continental communication lines, from ultra-precise measurements to compact discs and laser printers.

Obviously, such a long period of 35–40 years, which was required to start a rapid practical development of this fundamental discovery, can be explained by the unordinary nature of the discovery. This discovery became a new instrument in the hands of humanity, and it was necessary to create a new technological base and review the developed technical concepts in order to realize the discovered possibilities.

One can only be surprised at Nikolai Gennadievich's tremendous intuition – and these are not just «nice words». I myself well remember the skepticism evoked by his forecast for the development and application of the lasers.

освоения этого фундаментального открытия, –может быть объяснён неординарностью открытия, давшего в руки человечества прибор, для реализации возможностей которого было необходимо создать новую технологическую базу и пересмотреть сложившиеся технические концепции.

Можно только удивляться огромной интуиции Николая Геннадиевича – и это не просто красивые слова, поскольку я сам хорошо помню, какое скептическое отношение вызывал у многих его прогноз развития и внедрения лазеров.

Кстати, здесь я не могу не упомянуть о том, что Николая Геннадиевича неизменно поддерживал Дмитрий Владимирович Скобельцын и что одним из тех, кто в Президиуме АН СССР с постоянным интересом относился к выступлениям Николая Геннадиевича на эту тему, был Пётр Леонидович Капица.

Исследования Н. Г. Басова и его сотрудников привели к созданию широкого семейства новых лазеров: фотодиссоционных (на атомах йода), основанных на накачке сильной ударной волной, электроионизационных, эксимерных, химических и других лазеров.

Н. Г. Басов с О. Н. Крохиным и Ю. М. Поповым были первыми учёными в мире, которые предложили использовать полупроводники в качестве активной среды для лазеров, возбуждаемых различными методами, включая инжекцию носителей через р-п-переход. Этот метод привёл к появлению инжекционных диодных лазеров, которые наиболее широко используются как в науке, так и в технике.

В 1962 году Н. Г. Басов выдвинул идею достижения реакции термоядерного синтеза путём лазерного облучения малой мишени.

В то время энергия излучения лазера была настолько мала, что изначально идея казалась нереалистичной. Однако благодаря научному мужеству, неисчерпаемой энергии, упрямству, настойчивости и вере в правильность научной идеи Басов добился, казалось бы, невозможного: первые термоядерные лазерные нейтроны были получены в Физическом институте имени П. Н. Лебедева в 1968 году лазерным облучением мишени из дейтерида лития. Эти результаты стали мощным стимулом для изучения лазерного термоядерного синтеза во всём мире.

В настоящее время многие рассматривают лазерный термоядерный синтез как один из перспективных подходов к мирному использованию ядерной энергии.

By the way, here I cannot help but mention that Nikolai Gennadievich was invariably supported by Dmitry Vladimirovich Skobeltsyn. I should also note that academician Pyotr Leonidovich Kapitsa was always interested in Nikolai Gennadievich's speeches on this topic at the Praesidium of the USSR Academy of Sciences.

The research work of N. G. Basov and his collaborators resulted in the development of a wide family of new lasers: the photodissociation (on iodine atoms) lasers pumped by a strong shock wave, the electroionization *(e-beam sustained discharge – ed. remark)*, the excimer, the chemical, and other types of lasers. N. G. Basov, O. N. Krokhin and Yu. M. Popov were the first scientists in the world to propose the use of semiconductors as an active medium for the lasers excited by various methods, including the carrier injection through a p-n junction.

This method led to the creation of injection diode lasers, that are most widely used both in science and in technology.

In 1962, N. G. Basov put forward the idea of achieving a thermonuclear fusion reaction by laser irradiation of a small target.

At that time, the laser output energy was so low that initially the idea seemed to be unrealistic. However, thanks to scientific courage, inexhaustible energy, stubbornness, persistence, and faith in the correctness of the idea, Basov achieved the seemingly impossible: the first thermonuclear laser neutrons were generated at the Lebedev Physical Institute in 1968 by laser irradiation of lithium deuteride target. The obtained results have become a powerful stimulus for studying the laser thermonuclear fusion throughout the world.

Nowadays the laser thermonuclear fusion is considered by many scientists to be one of the promising approaches to a peaceful use of nuclear energy.

I would like to note one more feature of Nikolai Gennadievich, i. e. a special logic of his thinking.

Basov apparently followed a logic that contrasted with the thinking based on the most simple procedure, that is, moving from basic physics, as outlined in textbooks, to more complex concepts.

Sometimes it seemed that Nikolai Gennadievich followed the opposite direction in his reasoning, from the final result. Here is a story that my colleagues, who worked with Nikolai Gennadievich in the mid-fifties, told me. A few words about it I heard from him personally. The story concerns the maser linewidth. Nikolai Gennadievich believed that the stimulated-radiation spectral line might

Мне хотелось бы отметить ещё одну черту Николая Геннадиевича – особенную логику мышления, которая развивалась не по самому простому пути – от основ физики, изложенных в учебниках, к более сложным комплексным построениям.

Иногда думается, что Николай Геннадиевич шёл по противоположному пути – от конечного результата. Известна история, которую рассказывали мои коллеги, работавшие с Николаем Геннадиевичем в середине 50-х годов. Несколько слов об этом я слышал и от него самого. Эта история связана с вопросом о ширине линии мазера. Николай Геннадиевич считал, что ширина линии при индуцированном усилении за счёт регенерации в резонаторе может быть существенно более узкой, чем естественная ширина линии перехода. Логика его рассуждений была простой – ведь мазер является автоколебательной системой. Говорят, что Л. Д. Ландау, к которому Николай Геннадиевич ходил консультироваться, первоначально такую возможность отвергал, поскольку она противоречила бы соотношению неопределённости. Однако впоследствии это явление нашло закономерное объяснение с привлечением принципа неразличимости молекул, влетающих в резонатор.

По-видимому, Н. Г. Басов считал необходимым построить модель явления по-своему, отличающуюся (и, вероятно, более сложную) от моделей его коллег. С этим, можно полагать, связано то, что при обсуждении того или иного вопроса нам, его ученикам, иногда нелегко было сразу понять Николая Геннадиевича, поскольку он, скорее всего, считал, что слушатели мысленно уже прошли ту часть пути, которую он прошёл сам. Это уникальное мышление было источником лучших идей, которые были характерны для его творчества. Обычно считается, что если одна идея из 10 порождает практическую реализацию – это большой успех. Но для Н. Г. Басова процент реализованных идей был намного выше. Существует три уровня познания: на первом этапе наблюдается новое явление; на втором этапе объясняется это явление, и на третьем этапе используются полученные знания как инструмент исследования и применения. Многие экспериментаторы ограничиваются первым этапом; теоретики – вторым; и лишь несколько выдающихся учёных достигают третьего этапа. Н. Г Басов принадлежал к третьей группе.

Физика как наука или физика как технология занимали его ум, был ли он дома, в машине,

be narrower than the natural linewidth because of regeneration in the cavity.

The logic of his reasoning was simple: the maser in fact was an auto-oscillatory system. They say that L. D. Landau, to whom Nikolai Gennadievich came for advice, initially rejected this possibility, since it would contradict the uncertainty principle.

However, later on that phenomenon found a logical explanation with the use of the principle of indistinguishability of molecules entering the resonator.

Apparently, Basov believed it necessary to construct the model of the phenomenon in his own way, different from the models of his colleagues (and, probably, more complicated). And when Nikolai Gennadievich discussed this or that question with us, his students, it was not easy sometimes to immediately understand him. Most likely he thought that the listeners mentally had already passed the part of the way he had already covered himself. Such a unique thinking was the source of the best ideas that were characteristic of his work. Usually, it is believed that if one idea out of 10 ideas gives rise to practical implementation, it is a great success. But for Basov the percentage of realized ideas was much higher.

There are three levels of cognition: at the first stage one observes a new phenomenon, at the second stage one explains this phenomenon, and at the third stage one uses the obtained knowledge as a research and application tool. Many experimentalists restrict themselves to the first stage; the theorists, to the second one; and only a few outstanding scientists reach the third stage.

Nikolai Gennadievich belonged to the third group.

Physics as science or physics as technology, occupied his mind, whether he was at home, in the car, on vacation, or ill. He was a scientist who devoted all his strength, knowledge and tremendous talent to the development of science in Russia.

The contribution of N. G. Basov and his scientific school to modern science is great and diverse.

The range of his scientific ideas and results is impressive: from the physics of lasers to the laser location of the Moon, from the fundamental problems of coherence to the laser cathode ray tubes, autonomous mobile laser devices and high power lasers for antimissile defense.

The international reputation of the Lebedev Physical Institute and its scientists is largely the result of long and distinguished activity of N. G. Basov.

в отпуске или болен. Он был учёным, который посвятил все свои силы, знания и огромный талант развитию науки в России.

Вклад Н. Г. Басова и его научной школы в современную науку огромен и разнообразен.

Диапазон его научных идей и результатов был внушительным – от физики лазеров до лазерной локации Луны, от фундаментальных проблем когерентности до лазерных электронно-лучевых трубок, автономных мобильных лазерных установок и мощных лазеров для противоракетной обороны.

Международная репутация Физического института им. П. Н. Лебедева и его учёных во многом была обязана его деятельности.

Николай Геннадиевич оставил после себя большой научный коллектив, свою научную школу. Творческий заряд, переданный Н. Г. Басовым своим ученикам и последователям, дал возможность двигаться вперёд по пути реализации его идей и привёл к многочисленным новым научным результатам.

Академик РАН
О. Н. Крохин

Nikolai Gennadievich has left behind him a large team of scientists, his scientific school. The creative power transmitted to his pupils and followers made it possible to realize his ideas and to obtain new scientific results.

O. N. Krokhin
Academician of
Russian Academy of Sciences

Марочный лист из марок, выпущенных в 2022 году в честь 100-летия со дня рождения Н. Г. Басова.

A sheet of postage stamps issued in 2022 in honor of the Centenary of N. G. Basov's birth

Отец – Геннадий Фёдорович Басов (1891–1962) и мама – Зинаида Андреевна Басова (Молчанова) (1899–1970).

Father – Gennady Fedorovich Basov (1891–1962) and mother – Zinaida Andreevna Basova (Molchanova) (1899–1970).

PARENTS

Nikolai Gennadievich Basov was born on December 14, 1922 in the town of Usman, Tambov province (now Lipetsk region). His maternal grandfather, Andrey Kirillovich Molchanov, was a priest of the Usman's Church of the Intercession. His mother, Zinaida Andreevna, graduated from the Usman female gymnasium with a gold medal.

Father, Gennady Fedorovich Basov, was a graduate of the St. Petersburg Polytechnic Institute, a hydraulic engineer, was engaged in building industrial enterprises and water supply systems in Usman, later became a professor at the Voronezh Forestry Institute.


АВТОБИОГРАФИЯ

Басова Николая Геннадиевича

Родился 14 декабря 1922 года в г. Усмани Воронежской обл. Отец в это время был студентом Ленинградского политехнического института, мать учащаяся гимназии, а позже служащая.

Из автобиографии Николая Геннадиевича Басова: «Родился 14 декабря 1922 года в г. Усмани Воронежской области[1]. Отец в это время был студентом Ленинградского политехнического института, мать – учащаяся гимназии, позже служащая».

From the autobiography of N. G. Basov: «I was born on December 14, 1922 in the town of Usman of the Voronezh region[1]. My father was at that time a student of the Leningrad Polytechnic Institute and my mother was a pupil of a gymnasium, and later, an employee».

[1] *– В момент написания автобиографии г. Усмань находился в Воронежской области (примечание редактора).*

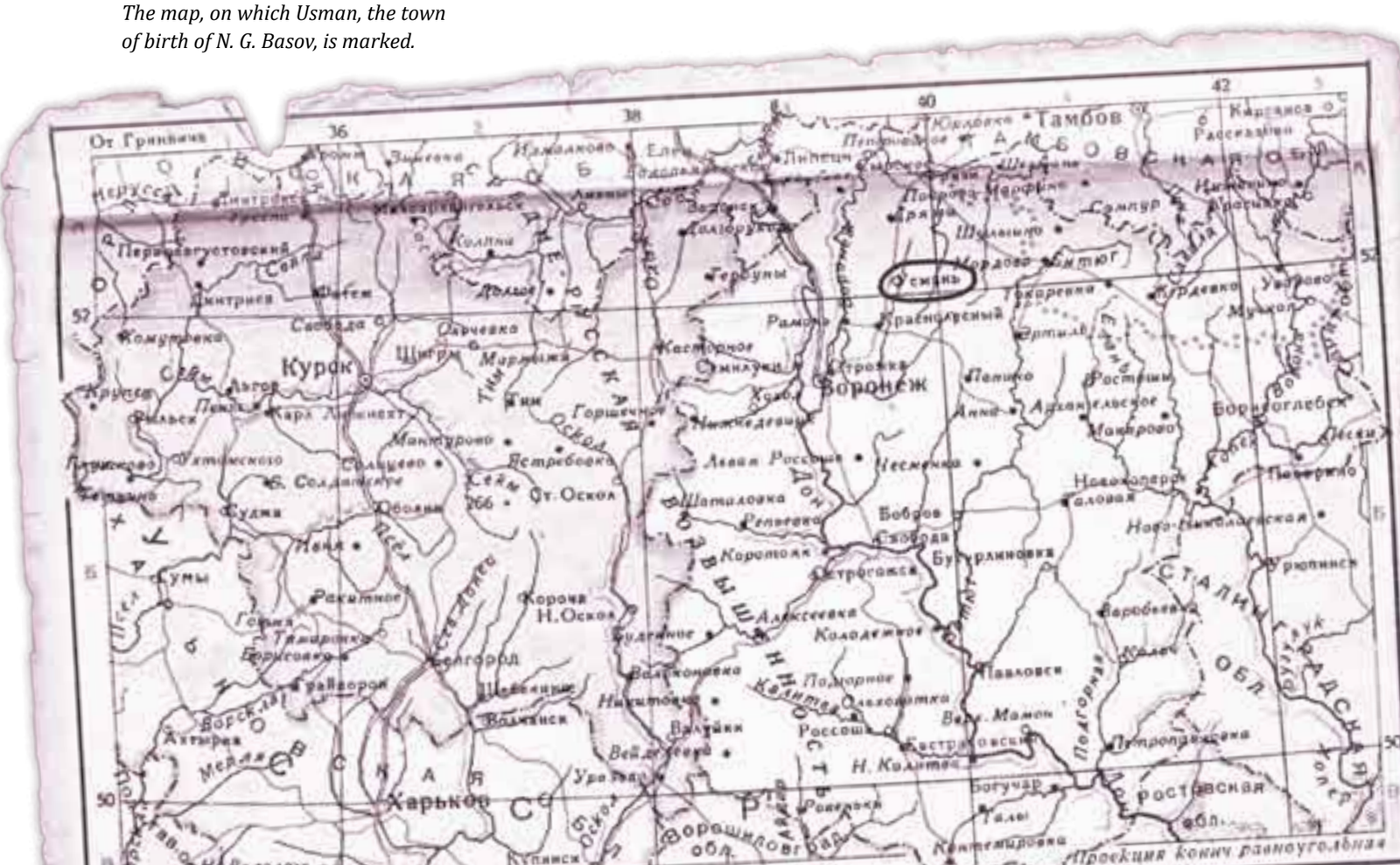
[1] *– When the autobiography was written, the town of Usman belonged to the Voronezh region (ed. remark).*

Коля Басов на руках в центре, его мама Зинаида Андреевна сидит правее, держит на руках его младшего брата Володю, крайний справа – отец Геннадий Фёдорович. 1925 г.

Little Kolya Basov (Kolya is a pet name for Nikolai – ed. remark) sits in the arms in the center, his mother Zinaida Andreevna sits to the right holding his younger brother Volodya, the far right – his father Gennady Fedorovich, 1925.

Карта, на которой выделен город Усмань, в котором родился Н. Г. Басов.

The map, on which Usman, the town of birth of N. G. Basov, is marked.



Семья Басовых среди друзей. Николай – второй слева в верхнем ряду. Усмань. 1926 г.

The Basov family among friends. Nikolai – second from the left in the upper row, Usman, 1926.

MOVING TO VORONEZH

Since 1926, Gennady Fedorovich Basov taught hydraulic engineering, hydraulics, hydrogeology, and drilling at the Voronezh State University, and in 1931 he switched to work at the Voronezh Forestry Institute, the department of hydraulic engineering melioration, first as an associate professor, and then as a professor. *(A. Borovik)*

IN THE CARE OF THE AUNT-MATHEMATICIAN

The Basov family moved from Usman to Voronezh at the end of 1926, but did not lose contact with their hometown. Here remained the sister of Gennady Fedorovich, a teacher of mathematics, Taisya Fyodorovna. She lived alone. She devoted herself completely to what she loved, and was considered as the strongest mathematician in the county.

The Basov family often visited Taisya Fyodorovna, and little Kolya lived with her every summer, sometimes stayed for the winter. *(Kolya is a pet name for Nikolai – ed. remark)*. In the second and third grades, he was completely in the care of his aunt. It will take a long time, and Kolya Basov, having become a great scientist, will say with excitement in his voice:

– I owe my passion for mathematics and physics to Aunt Taisya. It was she who taught me to think and introduced me into the fascinating world of exact sciences. *(A. Borovik)*

Коля Басов и собака Тузик. 1935 г.

Kolya Basov and dog Tuzik, 1935.

Братья Володя и Коля Басовы.

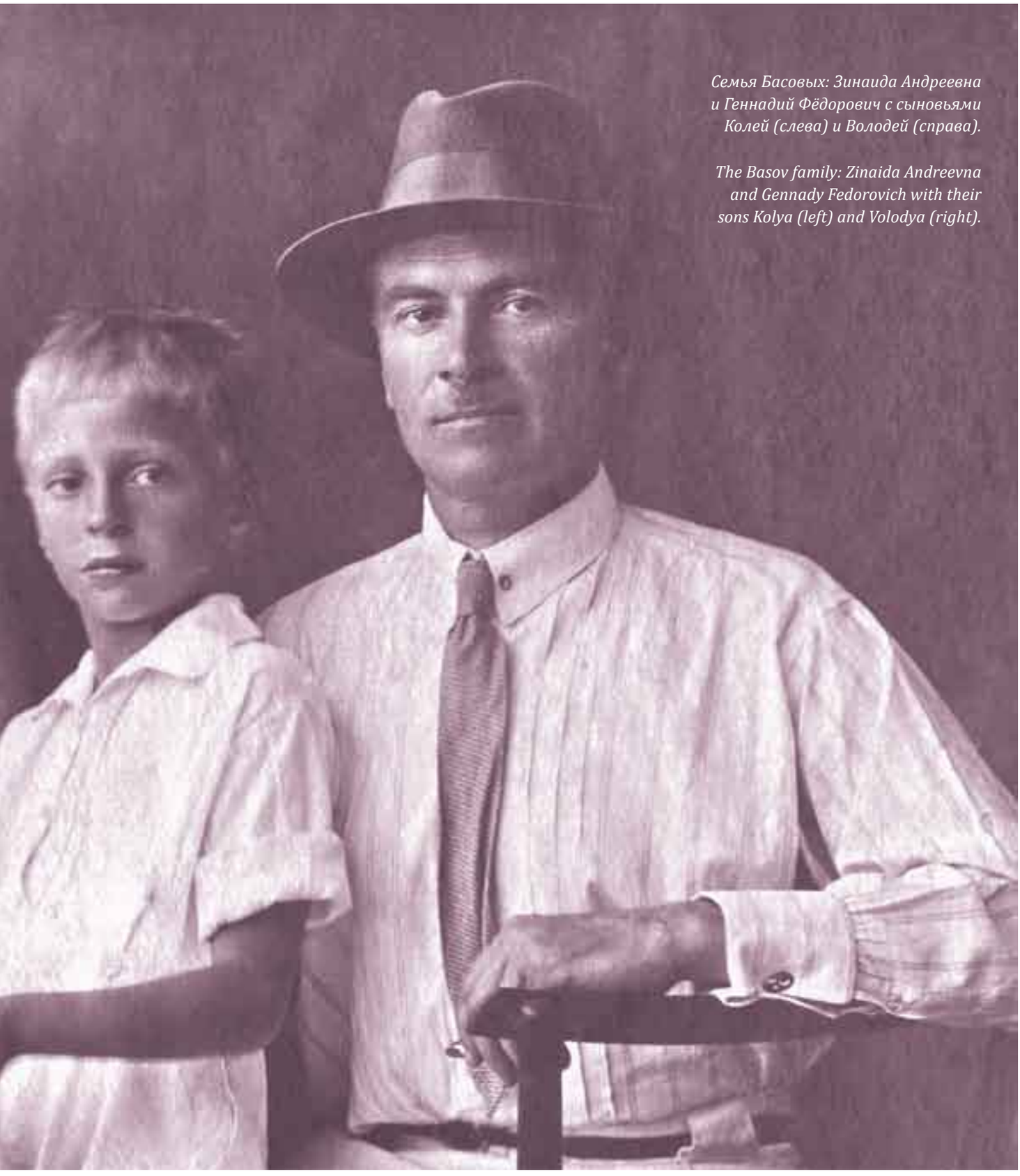
The brothers: Volodya and Kolya Basov.

Коля Басов. 1927 г.

Kolya Basov, 1927.

THE BIRTH PLACE

Kolya Basov finished the second and third grades of the Usman school. And then, having become a high school student, he used to come to Usman every summer, this time with his brother Volodya. The bright memories of childhood and adolescence – unforgettable trips with his father and brother to Usmansky pine forest, walks along the Tatarsky rampart, quiet dawns with fishing rods on the stretch of water in Dal'naya Peskovatka, resting at night in meadows on a fragrant haystack – all this connected him with his dear homeland and will forever accompany him. *(A. Borovik)*



Семья Басовых: Зинаида Андреевна и Геннадий Фёдорович с сыновьями Колей (слева) и Володей (справа).

The Basov family: Zinaida Andreevna and Gennady Fedorovich with their sons Kolya (left) and Volodya (right).

TO BE LIKE FATHER

Gennady Fedorovich was fond of technology, loved classical music. All this was inherited from him by sons Nikolai and Vladimir. There was a library in the house. The professor admired classical literature.

Pushkin, Lermontov, Gogol, Dostoevsky, Tolstoy – this was the circle of his interests. On his desktop, there often appeared books of a forgotten writer Alexander Ivanovich Ertel, the writer of the post-reform Russia who lived in Usman for a long time.

Gennady Fedorovich's grandfather, Stepan, who was a serf from the village of Devitsy, served as a prototype for one of the heroes of «Stepnyak's Notes». The father often liked to tell his sons about this. *(A. Borovik)*

Воронеж. 1939 г.

Voronezh, 1939.

FIRST AWARD

A passion for technology passed from father Gennady Fedorovich to his sons. Father fiddled with chemical solutions, soldered pots and radios, made a homemade drill. The house was full of all kinds of homemade things. The neighbors and friends have always wondered at how he had enough time for everything.

The eldest son Nikolai recalled: «I owe everything to my father. He knew how, «without whip and a stick», to turn us where needed. I don't know how he did it. He made us fall in love with classic literature. Saved us from unnecessary «tinsel».

Thanks to his father, Kolya Basov became interested in technique early. His first repair was the electric iron. Then there were many other things he repaired. He went to the technical station and became the best young technician. His mobile wind electric station was exposed at the All-Union agricultural exhibition. For it, young Kolya received the first award in his life – a diploma and a voucher ticket to the Caucasus resort. *(A. Borovik)*


С 1926 г. наша семья живёт в г. Воронеже
В 1930 г. поступил в 1-ую сред[нюю] школу г. Воро-
неша, в которой окончил 7 классов. С 8-го класса
учился в 13 ср. школе г. Воронежа, которую
окончил в 1941 году с аттестатом отличника
В 1940 году вступил в комсомол

Из автобиографии Н. Г. Басова: «В 1930 г. поступил в 1-ю среднюю школу г. Воронежа, в которой окончил 7 классов. С 8-го класса учился в 13 ср. школе г. Воронежа, которую окончил в 1941 году с аттестатом отличника. В 1940 году вступил в комсомол».

From the autobiography of N. G. Basov: «In 1930, I entered the 1-st secondary school in Voronezh, and graduated from the 7th grade. From the 8th grade I studied at the 13th Voronezh secondary school, and graduated in 1941 with excellent marks. In 1940 I joined the Komsomol».

«SERIOUS» BOOKS

Being the 6th grade pupil Kolya Basov received his first «serious» books on physics. Already in the 9th grade, he was reading a book by Albert Einstein, which he would take with him going to the front-line during the World War II, and did not part with it until the very Victory. *(A. Borovik)*

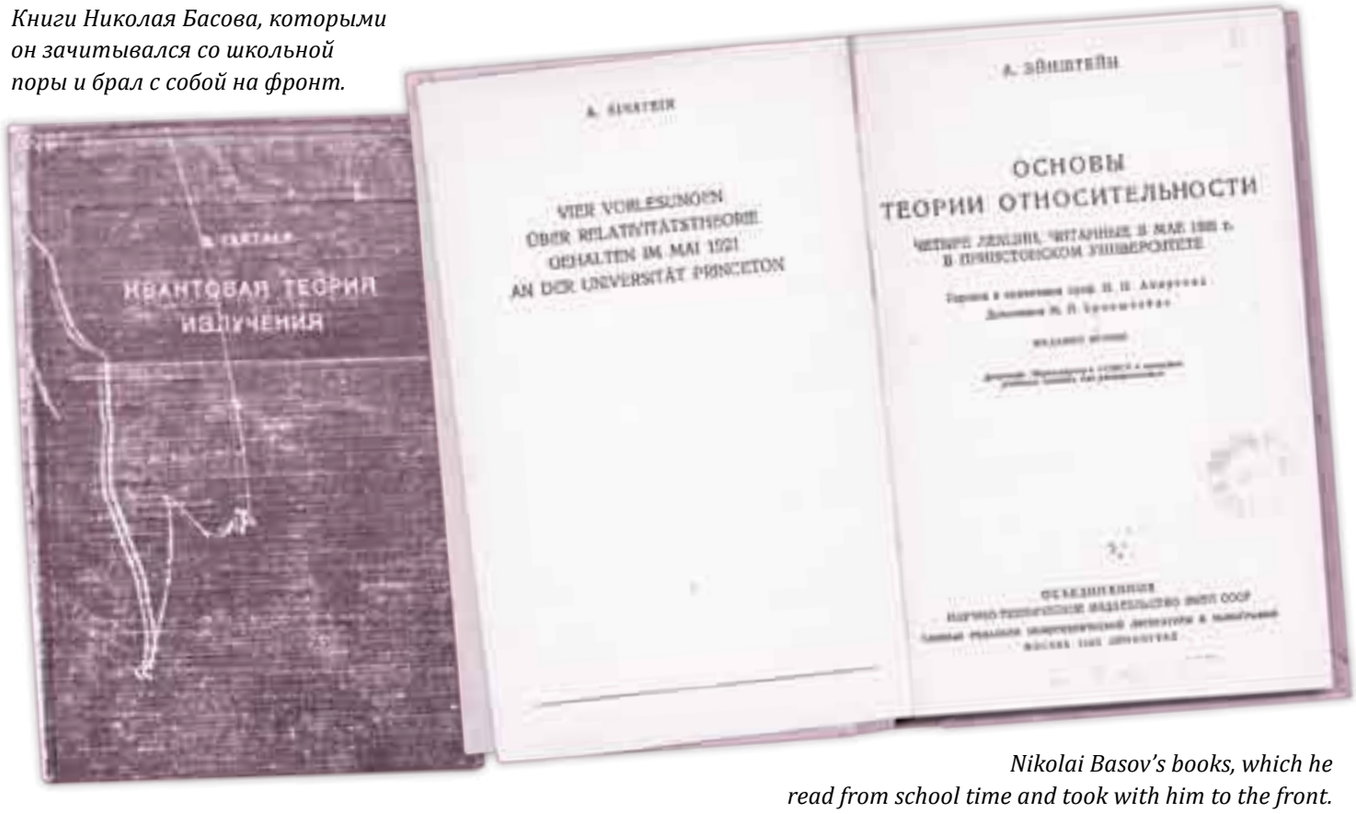
THE WAY TO SCIENCE

How did my journey into the science begin? Probably from a school where I first became interested in physics. I read a lot about the relativity theory, the quantum theory. Even then I understood that it was physics where great discoveries should be expected: the theory of relativity, quantum mechanics and the world of the atomic nucleus – all this signified the rapid growth of science. Fission of the uranium nucleus had already been discovered, the possibility of a chain nuclear reaction had been proven, pure uranium was isolated, the first transuranic element, neptunium, was synthesized. Prominent physicists under the leadership of E. Fermi had demonstrated a nuclear chain reaction in the first nuclear reactor. *(N. G. Basov)*

Время окончания школы совпало у меня с трудным периодом военного времени. Закончив среднюю школу в Воронеже, я стал слушателем Куйбышевской военно-медицинской академии. (Н. Г. Басов)

N. G. Basov: «The time of graduation coincided with the difficult period of the war. After graduating from secondary school in Voronezh, I became a student of the Kuibyshev Military Medical Academy».

Книги Николая Басова, которыми он зачитывался со школьной поры и брал с собой на фронт.



Nikolai Basov's books, which he read from school time and took with him to the front.

Н. Г. Басов – слушатель Военно-медицинской академии. Куйбышев, 1941 г.

N. G. Basov – student of the Military Medical Academy, Kuibyshev. 1941.

Курсанты Киевского военно-медицинского училища. Н. Г. Басов – первый слева в 3-м ряду. Свердловск, 1943 г.

Students of the Kiev military-medical school, N. G. Basov – in the 3-rd row, first on the left, Sverdlovsk, 1943.

MEDICAL EDUCATION IN WARTIME

Nikolay Basov's graduation from school coincided with the beginning of the Great Patriotic War. In 1941, Nikolai was drafted into the Red Army and sent to the Kuibyshev Military Medical Academy, in 1942 he was transferred to the Kiev military medical college that was evacuated to Sverdlovsk.

After graduating from the college in 1943, Nikolai was given the rank of lieutenant, awarded with a diploma, got a set of surgical instruments, and sent to the front. Nikolay Basov served as a doctor's assistant in the chemical defense battalion of the Red Army as a part of the 1st Ukrainian Front. *(A. Borovik)*

Из анкеты Н. Г. Басова.

From the questionnaire of N. G. Basov.

19. Выполняемая работа с начала трудовой деятельности (включая учебу в высших и средних специальных учебных заведениях, военную службу, участие в партизанских отрядах и работу по совместительству).

При заполнении данного пункта учреждения, организации и предприятия необходимо писать так, как они назывались в свое время, военную службу записывать с указанием должности.

Месяц и год поступления	Месяц и год ухода	Должность с указанием учреждения, организации предприятия, а также министерства (ведомства)	Местонахождение учреждения, организации, предприятия
УШ.41	XI.42	Слушатель Куйбышевской военно-медиц. академии.	г.Куйбышев
XI.42	УП.43	Курсант Киевского военно-медицинского училища.	г.Свердловск
УП.43	УШ.45	Командир сан.дегаз.отд. 3 ОБХЗ	МВО,1 Украинск.фронт
УШ.45	ХП.45	Фельдшер 70 СКП	ЦГВ
П.46	УП.50	Студент Инженерно-физического факуль-	Москва

Н. Г. Басов – лейтенант медицинской службы (второй справа). Подмосковье. 1943 г.

N. G. Basov, the lieutenant of medical service (second on the right), Moscow region, 1943.

Lieutenant of the medical service Nikolai Basov served in the chemical defense battalion. He carried the wounded soldiers from the battlefield, gave them first medical aid, sent them to the hospital, covered the river crossings with smokescreens, neutralized the chemical plants of the enemy. *(A. Borovik)*


НКО—СССР

35-й Отдельный
БАТАЛЬОН ХИМЗАЩИТЫ

ВРЕМЕННОЕ УДОСТОВЕРЕНИЕ.

Удостоверение лейтенанта медицинской службы 35-го отдельного батальона химзащиты. 1944 г.
Certificate of the medical service lieutenant of the 35th Separate chemical defense battalion, 1944.

WITHOUT ANESTHESIA

This is what happened once. The soldiers were digging dugouts. The work was hard, and suddenly one of the soldiers had a severe attack of appendicitis. It was necessary to cut it out, to do a surgery, but I only once saw how the professor removed the appendix, assisted him a little during the surgery, giving him different instruments. So, I asked four soldiers to hold the sheet over the patient (dirt and sand were falling from the roll of the dugout), gave him half a glass of alcohol instead of anesthesia, and made the surgery. By the way, this guy is still alive *(N. G. Basov)*

Н. Г. Басов. *N. G. Basov.*

IN THE RANKS OF THE SOVIET ARMY

In 1945, after the victory over Germany, Nikolai took part in the dismantling of German chemical plants. There was an accident: he got mustard gas on his leg while he was assisting a soldier. On another occasion, poisoning seemed to be occurred with potassium cyanide, and he was hospitalized with loss of vision and a severe decrease in hemoglobin. Fortunately, his eyesight was recovered pretty quickly, and his fellow soldiers released him early from the hospital ahead of schedule. *(K. T. Basova)*

16. Имеются ли у Вас родственники за границей, где, с какого времени и чем занимаются (фамилия, имя, отчество и степень родства).	не были
17. Были ли Вы или Ваши ближайшие родственники в плену или интернированы в период Отечественной войны, где, когда, при каких обстоятельствах освобождены.	отец и мать находились на территории оккупированной немцами в гор.Воронеже в 1942 г.

Фрагмент из анкеты Н. Г. Басова.
From the questionnaire of N. G. Basov.

С 7 июля 1942 года по 25 января 1943 года Воронеж, частично находясь под немецкой оккупацией, понёс значительный ущерб: в Воронеже было разрушено 18 тысяч домов (92% всех жилых зданий).

The Voronezh city was partially under the German occupation from July 7, 1942 to January 25, 1943, and suffered considerable damage: 18,000 homes were destroyed (92% of all residential buildings).

После окончания училища был направлен в 35 отдельной батальон Хим-Защиты, с которым участвовал в Отечественной войне на 1 Укр. фронте (с начала 1945г) В мае 1945 г. был тяжело отравлен ОВ при демонтаже немецкого химзавода. В августе 1945 г. был направлен на Санитарно-контрольный пункт № 70, где работал дежурным фельдшером

Из автобиографии Н. Г. Басова: «После окончания училища был направлен в 35-й отдельный батальон химзащиты, с которым участвовал в Отечественной войне на 1-м Украинском фронте (с начала 1945 г.). В мае 1945 г. был тяжело отравлен ОВ при демонтаже немецкого химзавода. В августе 1945 г. был направлен на санитарно-контрольный пункт № 70, где работал дежурным фельдшером».

From the autobiography of N. G. Basov: «After graduation, I was sent to the 35th Separate chemical defense battalion and took part in the Patriotic war in the ranks of the 1st Ukrainian Front (from the beginning of 1945). In May 1945, I was seriously poisoned by the PS during the dismantling of the German chemical plant. In August 1945, was sent to the Sanitary-control hospital # 70, where worked as a duty paramedic».

Возвращение Н. Г. Басова домой после войны. Воронеж, 1945 г. Слева направо: Н. Г. Басов, Г. Ф. Басов (отец), В. Г. Басов (брат), З. А. Басова (мать).

Home coming from the war, Voronezh, 1945. Left to right: N. G. Basov, G. F. Basov (father), V. G. Basov (brother), and Z. A. Basova (mother).

AFTER THE WAR – TO LEARN RIGHT AWAY

The war for Nikolai Gennadievich ended only at the end of 1945. He returned to his native town of Voronezh to his parents and his brother, a disabled war veteran. Their house was destroyed, they lived in a barrack, and after a while they began to restore their house. Of course, he immediately began to think about studying, but there was no admission of students at the Voronezh University. So he went to Moscow, but the admission at Moscow State University was already over. There was an attempt to enter the Bauman Moscow Higher Technical School, but with no success too. He was quite ready to go back home, when riding a tram he accidentally saw an ad saying that there was an unscheduled winter enrollment of students to the Mechanical Institute, the Engineering-Physics Faculty. As it turned out, this faculty was urgently formed in February 1946 in connection with the atomic project. The outstanding scientists, Igor Evgenievich Tamm, Lev Andreevich Artsimovich, Isaak Konstantinovich Kikoin were invited to give lectures there, and one could mention many other great names. Nikolai Gennadievich became a student of the Mechanical Institute, which was later renamed the Moscow Engineering Physics Institute (MEPhI), and the faculty became known as the Faculty of Theoretical and Experimental Physics. Studying was happiness for him as he said later more than once. *(K. T. Basova)*

Студенты МИФИ Н. Басов (первый слева) и К. Назарова (вторая слева). 1946 г.

The students of MEPhI (Moscow Engineering Physics Institute): N. Basov (first left), K. Nazarova (second left), 1946.

THE STUDENT

After the war, I entered the Engineering Physics Faculty of the Moscow Mechanical Institute (now the Moscow Engineering Physics Institute, MEPhI). If not for the war, I would have studied at the Voronezh University, but the war changed my plans. *(N. G. Basov)*

EXTRAORDINARY ENROLLMENT OF STUDENTS

Nikolai Gennadievich told me how he got to the Institute. Once he was riding a tram and saw an ad about an extraordinary enrollment of students to the Moscow Mechanical Institute for those who had just demobilized from the front. Nikolai Gennadievich always loved his Institute, for him MEPhI was his home. *(O. N. Krokhin)*

FATEFUL MEETING

Winter 1946, a new faculty of Engineering physics was opened at the Moscow Mechanical Institute. Later, it became known as the Faculty of theoretical and experimental physics of MEPhI. Here I met Nikolai Gennadievich. This happened even before the start of classes at the Institute. As an applicant, I was instructed to maintain some kind of list of students. And a young man in an officer's uniform comes up to me and says his name – Basov. I remember how I was a bit startled, because it was my grandmother's name. *(K. T. Basova)*

С однокурсниками на первомайской демонстрации. В первом ряду слева – Николай Басов и рядом с ним Ксения Назарова (будущая жена). 1947 г.

With fellow students at the May Day demonstration. First row, left – Nikolai Basov, and beside him Kseniya Nazarova (his future wife), 1947.

AHEAD OF THE LECTURER

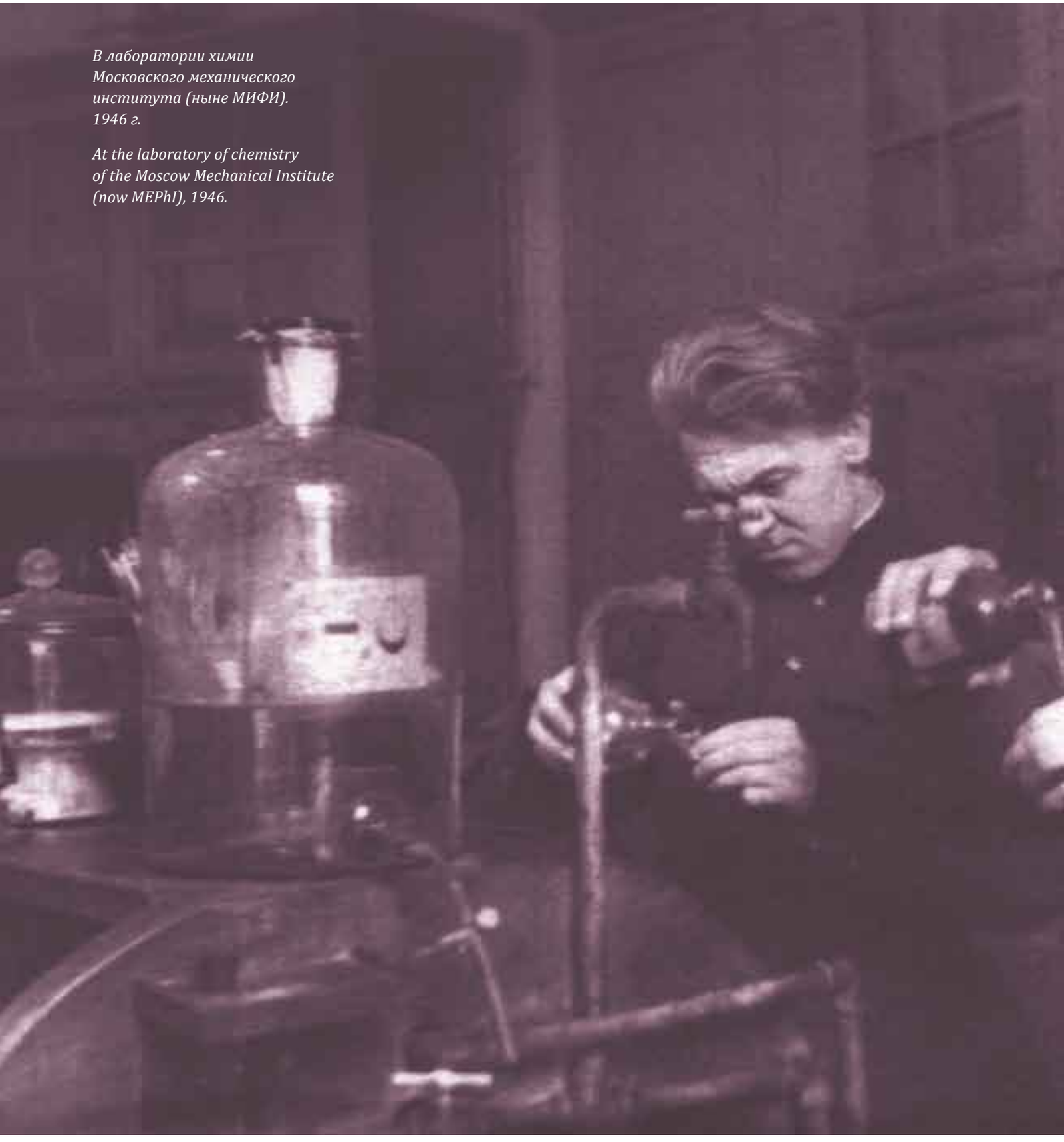
We were studying at the same course of the Institute. He – after demobilization after the front, I – after the school. Lectures were given to us by the most famous scientists: academicians Igor Evgenievich Tamm, Lev Andreevich Artsimovich, Isaac Konstantinovich Kikoin, Mikhail Alexandrovich Leontovich.

Many other names of remarkable physicists could be called. And the students were mostly front-line soldiers. Of course, it was very difficult for them to study after a break in their studies, but not for Basov. I noticed that, while recording lectures, he was often ahead of the lecturer himself and asked very difficult questions. Apparently, physics and mathematics have always been in his head, both during his studies in a military medical school, and then service as a para-medic in the army, until the end of war.

After classes, he was almost always waiting for me, and we went for a walk around Moscow. I don't even know where he got the time to study, and the same thing was with me. Our student life was like the poem written 30 years later by one of the Basov's students. In it, everything was the same as in our student days.

Wonderful autumn! Beauty outside the window.
You look out – and the soul falls in love.
But we don't look. We take integrals.
After all, time is not quantized.

(K. T. Basova)



В лаборатории химии Московского механического института (ныне МИФИ). 1946 г.

At the laboratory of chemistry of the Moscow Mechanical Institute (now MEPhI), 1946.

LUCKY MAN

Leontovich liked Nikolai Basov, who was an inquiring curious, thinking, and diligent student. They had a warm relationship. For the rest of his life, Leontovich will remain for Basov his real teacher, great and very demanding.

About the years of study, he would will say: «I am a happy man. I was very lucky in life and was lucky to listen to the lectures of a whole constellation of great scientists of our country, whose names are called with great respect not only in our country, but also abroad».

I am especially grateful to my beloved teacher Mikhail Aleksandrovich Leontovich, who believed in me and taught me how to work in the laboratory, successfully combining theory and experiment. *(A. Borovik)*

HARD LIFE AND GREAT TEACHERS

Student years were very hard for Basov. He initially lived in a dormitory that previously was a huge workshop of a former plant. They slept on cement floors, foundations of the removed machine tools.

It was colder in the dormitory than outside, and students lit fires right there to warm themselves. The scholarship stipend was not enough, and the students used to unload railway boxcars for as a part-time work. But studies brightened up all the difficulties. World-famous scientists worked at the Institute: Igor Evgenievich Tamm, Lev Andreevich Artsimovich, Isaac Konstantinovich Kikoin, Mikhail Alexandrovich Leontovich (a prominent radiophysicist, awarded with the Popov gold medal), Mikhail Dmitrievich Millionshchikov, and Evgeny L'vovich Feinberg, all of them soon became the academicians. *(A. Borovik)*

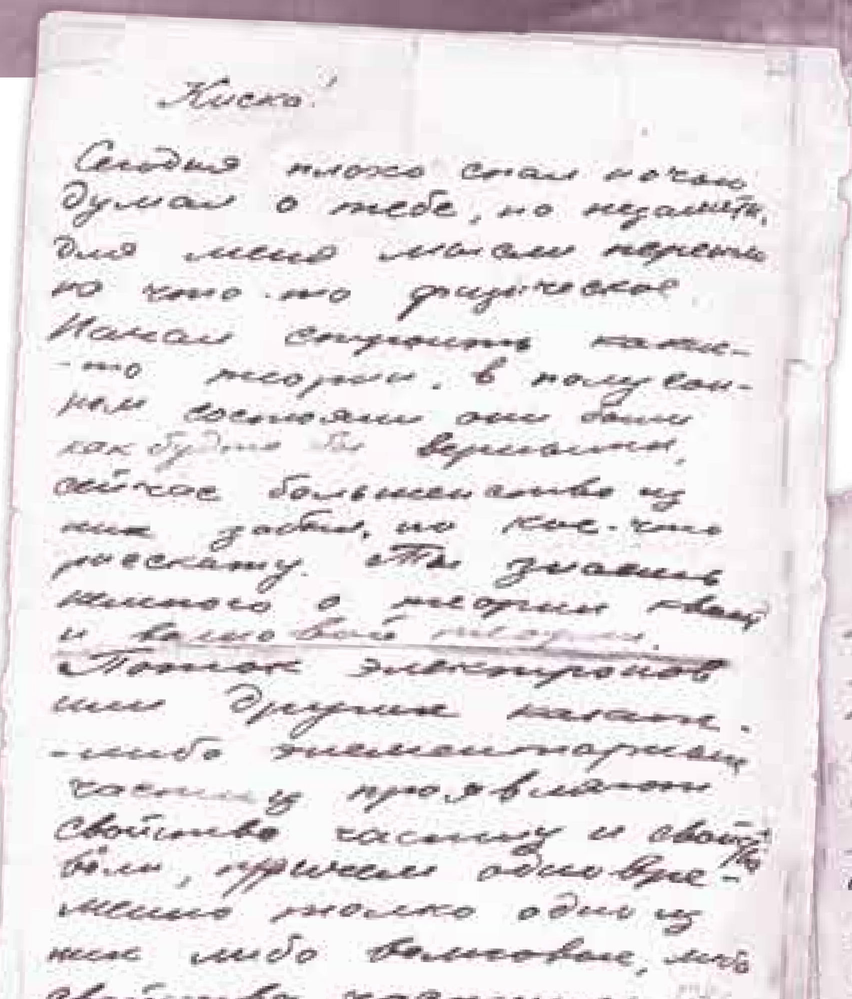
FASCINATING SCIENCE

We, students of those years, followed with great interest the outstanding discoveries and achievements of up-to-date physics. I was fascinated by science. From Newton's and Maxwell's laws, Roentgen's discoveries and Einstein theories to up-to-date theories of nuclear fission. *(N. G. Basov)*

In autumn, we found time to walk in a park through the rustling leaves, and in the spring to go boating in the Serebryany Bor. *(K. T. Basova)*

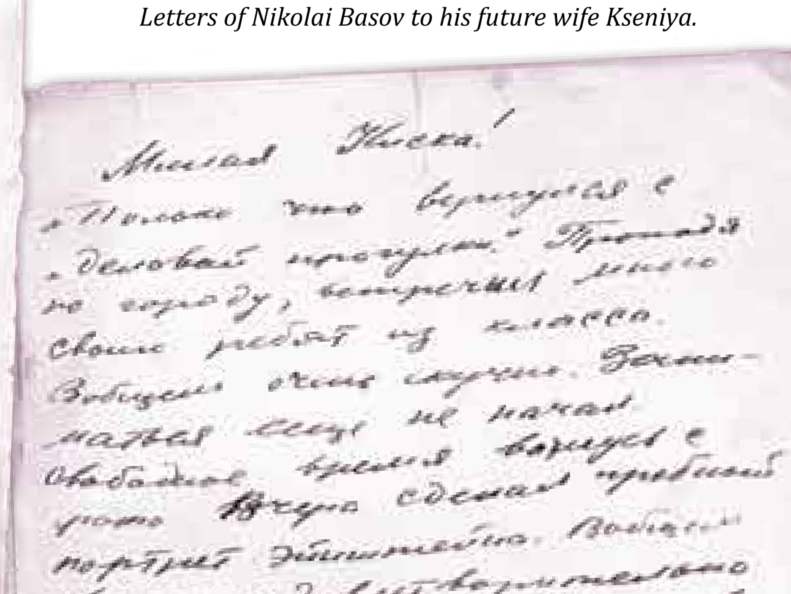
Н. Г. Басов с будущей женой Ксенией. Серебряный бор, 1946 г.

N. G. Basov with his future wife Kseniya, Serebryany Bor, 1946.



Киска!

Сегодня плохо спал ночью, думал о тебе, но недолго, для меня мысли перешли на что-то физическое. Начал строить какие-то теории. В полусонном состоянии они были как будто бы верными, сейчас большинство из них забыл, но кое-что расскажу. Ты знаешь немного о теории квант и волновой теории. Поток электронов или других каких-либо элементарных частиц проявляют свойство частиц и свойство волн, причем одновременно только одно из них либо волновое, либо



Милая Киска!

Только что вернулся с деловой прогулки. Проходя по городу, встретил много своих ребят из класса. Вообще очень скучно. Заниматься еще не начал. Свободное время вожусь с фото. Вчера сделал пробный портрет Эйнштейна. Вообще

Письма Николая Басова, адресованные его будущей жене Ксении.

Letters of Nikolai Basov to his future wife Kseniya.

During the holidays, Nikolai Gennadievich went to Voronezh to visit his parents. There he helped to renovate a house destroyed during the war, and wrote me letters almost every day – I still keep them. *(K. T. Basova)*

NIKOLAI BASOV'S LETTERS TO HIS BRIDE KSENIYA NAZAROVA

July 13, 1946

<...> Last night I slept badly, thought about you. But then, somehow, my thoughts turned to something connected with physics and I began to build theories. I was half asleep, and the theories seemed to be correct. I have forgotten most of them now, but here is something from it.

You know a little about quantum theory and wave theory. The flow of electrons or any other elementary particle demonstrates the properties of particles and the properties of waves, and at the same time, only one of them – either wave or particle properties. Therefore, there are two theories of matter: a corpuscular (particle) theory and wave theory. So, what is the matter?! Quantum theory can be postulated and matter can be considered to be a particle, and waves are the result of the energy discontinuity. The potential is energy, and the energy cannot change gradually, it fluctuates. Particles flying through space with a changing potential become oscillating, due to a uniformly interrupted change in the potential at the points of its change.

In fact, only particles with a small mass will oscillate.

I reconciled two theories.

Yes, from here the maximum value of the speed of light becomes clear. What about a potential, I haven't got it, yet. It is necessary to calculate the distance of potential change for different particles. This value being multiplied by velocity of a particle should be constant for all particles at a given point of space. If I am right, then the «relativity» theory will naturally follow from this. Well, you see where my fantasy has taken me. In general, it's all nonsense. Today I don't believe in it <...>

Будущая жена Н. Г. Басова – Ксения Тихоновна Назарова. 1949 г.

Kseniya Tikhonovna Nazarova, the future wife of N. G. Basov, 1949.

Without date

<...> I miss you as much as I have never missed. Another half a month remains until my coming to Moscow, I want the summer to end sooner, so that to see you. I am also reluctant to study yet, although when there is a time, I am happy to study relativity. I do not want to study, because this year I didn't have a rest – was busy at the construction site.

July 5, 1947

<...> Just returned from the garden. Dad and me pumped out honey from bees. I've been bitten by the bees. The right thumb is so swollen I can hardly write. I am at home for the second day, and I already very much miss you. I really, really want to see you. I've printed photographs and send them to you, only they do not fit in the envelope. I have to send it in parts. Which ones do you want to see the most? <...>

July 8, 1947

<…> I just returned from a «business walk». Walking through the city, I met many of my guys from the class. In general, it's very boring. I have not started studying yet. In spare time I work with photos. Yesterday I made a test portrait of Einstein. Well, it turned out not bad. I send you a small imprint from the same negative. Write to me. I miss you so much. I've had a sleep and was almost sure that your letter was waiting for me. But it was not there. Hope I'll get it tomorrow.

Kolya.
Hello to mom and Lucy.

August 2, 1947

<…> You are everything to me. When I think of you, everything else becomes very small and unimportant. I want to write you something, so that you understand how much I love you…

August 6, 1947

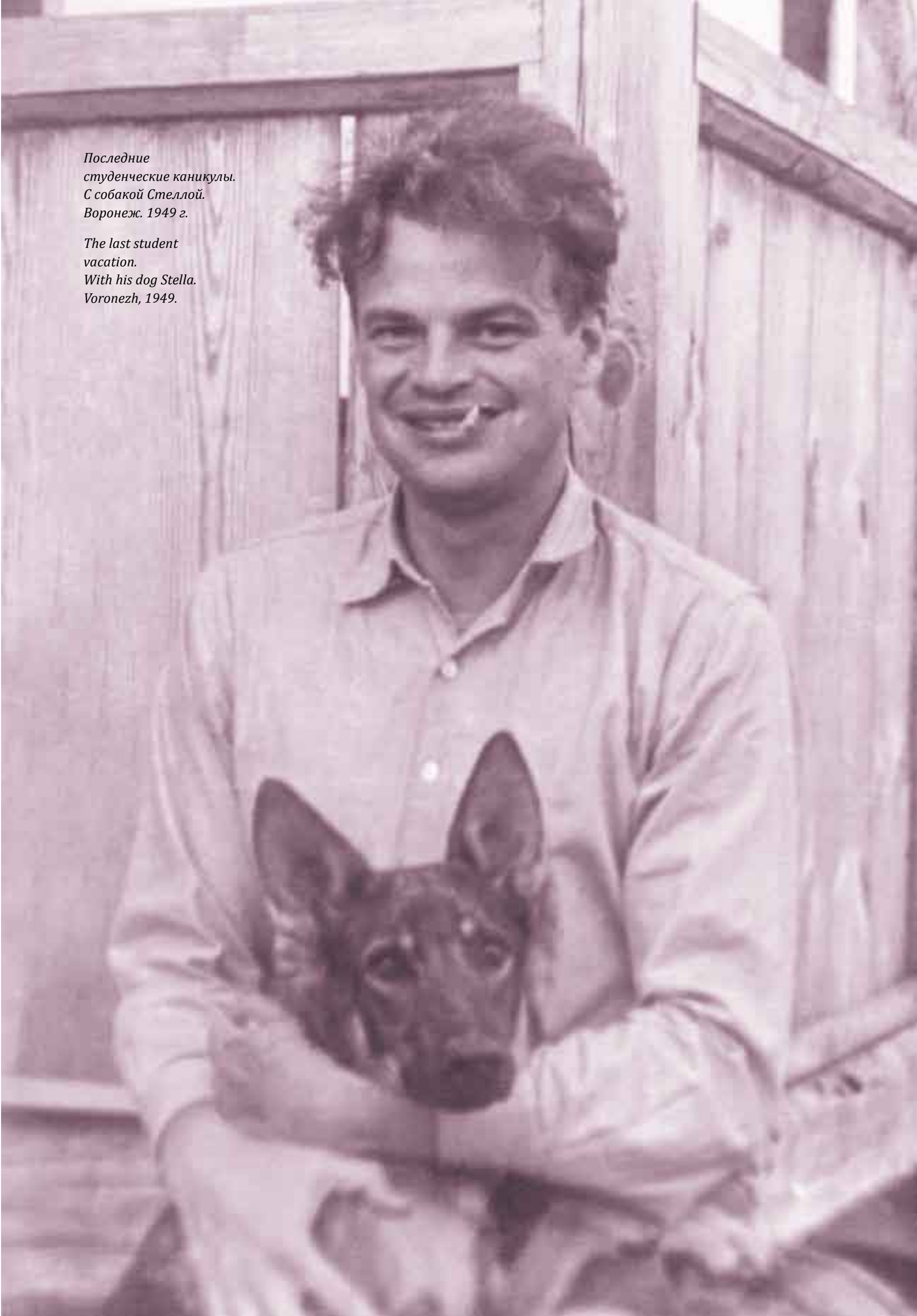
<…> My love to you has become the most important thing in my life. I love you and believe in you…

January 1, 1949

<…> The holidays are coming to an end, and there is still so much to do. My mechanics classes are progressing very badly. Not because I devote little time to it, but because the thing is rather difficult, especially in Landau's presentation. So many questions. I've read half of it only. I am stuck on tensors. Landau's book has a small appendix outlining tensors, but it is difficult to understand. It's a pity I did not take books with me, especially algebra. <…>

Ксения Назарова. 1949 г.

Kseniya Nazarova, 1949.



Последние студенческие каникулы. С собакой Стеллой. Воронеж. 1949 г.

The last student vacation. With his dog Stella. Voronezh, 1949.

Новое здание ФИАНа на Ленинском проспекте. 1950-е гг.

УЧЕБНАЯ ХАРАКТЕРИСТИКА

на студента IV-го курса инженерно-физического факультета Московского механического ин-та БАСОВА Николая Геннадиевича, рождения 1922 года, русский, член ВЛКСМ, из служащих.

Тов. БАСОВ Н.Г. учился в Московском механическом институте с февраля 1946 г. (поступил после демобилизации из Сов.Армии).

К учебной работе относится добросовестно и с большим интересом, систематически является отличником учебы.

Дисциплинирован, взысканий по учебной линии не имеет, систематически участвовал в общественной работе, в настоящее время работает председателем Совета физической секции Научно-технического студенческого общества.

Декан или представитель в физический Институт АН СССР им.П.Н.ЛЕБЕДЕВА.

Подпись

2 апреля 1949г.

МИНИСТЕРСТВО КУЛЬТУРЫ СССР
НАЧАЛЬНИК ГЛАВНОГО УПРАВЛЕНИЯ ВЫСШЕГО ОБРАЗОВАНИЯ

Директору физического института им.П.Н.Лебедева АН СССР

акад.СИНЕЛЬНИКОВУ К.Д.

Копия: Главному ученому секретарю Президиума АН СССР академику ТОПЧИЕВУ А.В.

В соответствии с постановлением Президиума АН СССР Главное управление высшего образования Министерства культуры СССР направляет окончившего машиностроительного инженерно-физического института т.БАСОВА Николая Геннадиевича на работу в физический институт им.П.Н.Лебедева АН СССР.

В.Ф.Рещикову

Прошу подготовить приказ о зачислении т. Басова

ВЫПИСКА ИЗ ПРИКАЗА № 130.

ПО ФИЗИЧЕСКОМУ ИНСТИТУТУ ИМ.П.Н.ЛЕБЕДЕВА «АКАДЕМИИ НАУК СССР.

г. Москва. « » июня 1949 г.

§ 8.

БАСОВА Николая Геннадиевича зачислить с 15.УП-1949 г. на должность инженера в лаб. колебаний с окладом 900 руб. в месяц / по совместам/.

Основание: Служебная записка т. зав.лаб., академика Л.А.Арцимовича с рез. Зам.Директора тов.Н.Г.Кризомосова.

записка верна: Нач.канц. отд. /Г.З. АСТАПОВА/

Документы о приёме выпускника ММИ Н. Г. Басова в ФИАН на должность инженера в лабораторию колебаний.

Documents on the admission of MMI (Moscow Mechanical Institute, MEPhI in future) graduate N. G. Basov to the Lebedev Institute (as an engineer in the laboratory of oscillations).

New building of the Lebedev Institute at the Leninsky prospekt in the 1950-ies.

INVITATION TO FIAN

As a student, I began to work as a laboratory assistant at the Lebedev Physical Institute at the invitation of academician Mikhail Aleksandrovich Leontovich, our famous physicist, and then as an engineer at the Oscillation lab., which was headed by Alexander Mikhailovich Prokhorov. Later on, we worked together with Prokhorov on our joint research. *(N. G. Basov)*

«MASTERING PHYSICS IN FULL»

I came to FIAN in 1948, several years after the war, and did not feel that any military research was being conducted there. All our thoughts were aimed at mastering physics in full, so that to be ready to develop our national economy. As for masers and lasers, then, of course, centimeter waves that were used in radio ranging location had been the a brainchild of the war. Radio engineering and radio physics were widely represented in our laboratory: on the one hand, radio astronomy was developing, on the other, radio spectroscopy. But we were engaged in these studies without any connection with military research. *(N. G. Basov)*

STUDY OF THE SYNCHROTRON RADIATION

At that time, there were performed researches of a synchrotron radiation on a small synchrotron at FIAN. Those studies were headed by Alexander Mikhailovich Prokhorov. He suggested that I should run this synchrotron in the multiple resonance mode, i. e., when the frequency of the exciting field is the integer (4–6) times higher than the particle rotation frequency. In order to register the radiation, we developed a facility for receiving centimeter waves. Along with this work, academician S. I. Vavilov, director of FIAN, entrusted A. M. Prokhorov with responsibility for radio spectroscopic research. We built radio spectroscopes, organized a seminar in Prokhorov's group, studied the theory and experiment of radio spectroscopy. *(N. G. Basov)*

Супруги Басовы. 1950.
Фотографировал отец Н. Г. Басова.

Spouses Basovs. 1950.
The photo is made by N. G. Basov's father.

FAMILY LIFE

We got married before defense of my diploma paper, which was devoted to molecular beams. And Nikolai Gennadievich, being still a student, worked already at FIAN in the group of A. M. Prokhorov. He was assigned over there by academician M. A. Leontovich, who headed the Oscillation lab. Under his guidance, Nikolay Gennadievich defended the diploma paper ahead of schedule and became his postgraduate. So I was already married to an engineer-physicist.

He moved from a student hostel to my family's communal apartment. I remember his wooden box tied with a soldier's belt, it contained old textbooks, a volume of works by Anatole France, as well as Einstein's «The Meaning of Relativity: Four Lectures», and W. Heitler's «The Quantum Theory of Radiation», which he carried with him through the entire war. There were also records of Prof. Rytov's lectures on the oscillation theory that we were rewriting in turn.

Nikolai was immediately relieved of household duties, to which he was never adapted, despite wartime or life in a hostel. But as for some technical work around the house apartment he did it excellently, knew how to fix, tune, put together. And he had, at last, his own writing table. But his main place of work was for him, of course, the FIAN laboratory, because he was not only a theoretician, but also an experimentalist and a very good engineer. *(K. T. Basova)*

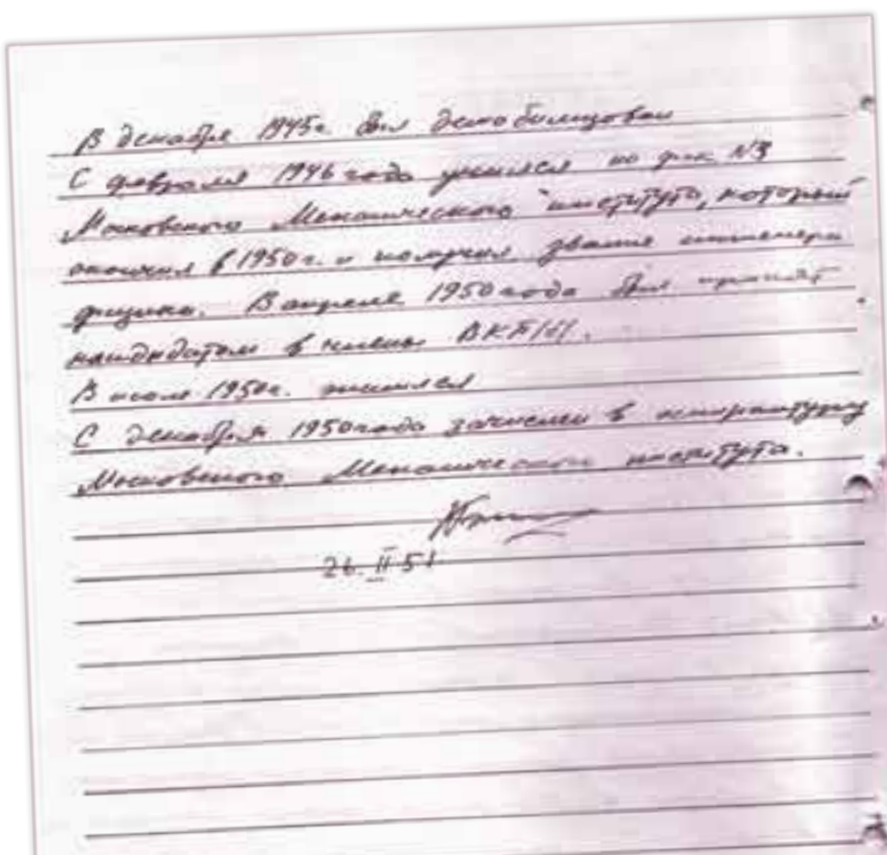
На каникулах в Воронеже.
Слева направо: Николай Басов и его брат Владимир.
1950 г.

On holidays in Voronezh. Left to right:
Nikolai Basov and his brother Vladimir, 1950.

К. Т. Басова.

K. T. Basova.

Из автобиографии Н. Г. Басова.
From the autobiography of N. G. Basov.



В декабре 1945 г. Вы демобилизовались
С февраля 1946 года учился на фак. №3
Московского Механического института, который
окончил в 1950 г. и получил диплом инженера
физика. В апреле 1950 года был принят
кандидатом в члены ВКП(б).
В июне 1950 г. женился
С декабря 1950 года зачислен в аспирантуру
Московского Механического института.

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Н. Г. Басов и первые молекулярные генераторы. Середина 1950-х годов.

N. G. Basov and the first molecular oscillators (masers) (the mid-fifties).

ATMOSPHERE OF THE POST-WAR YEARS

The level of physical research before the war was rather high in the Soviet Union. Soviet scientists had right to claim leading positions in world science. We clearly realized the spirit of creativity and quest, which was passed on to us by scientists of the older generation. And we tried to keep this high spirit and convey it to young people. This is how I would define the atmosphere in which we lived in the post-war years.

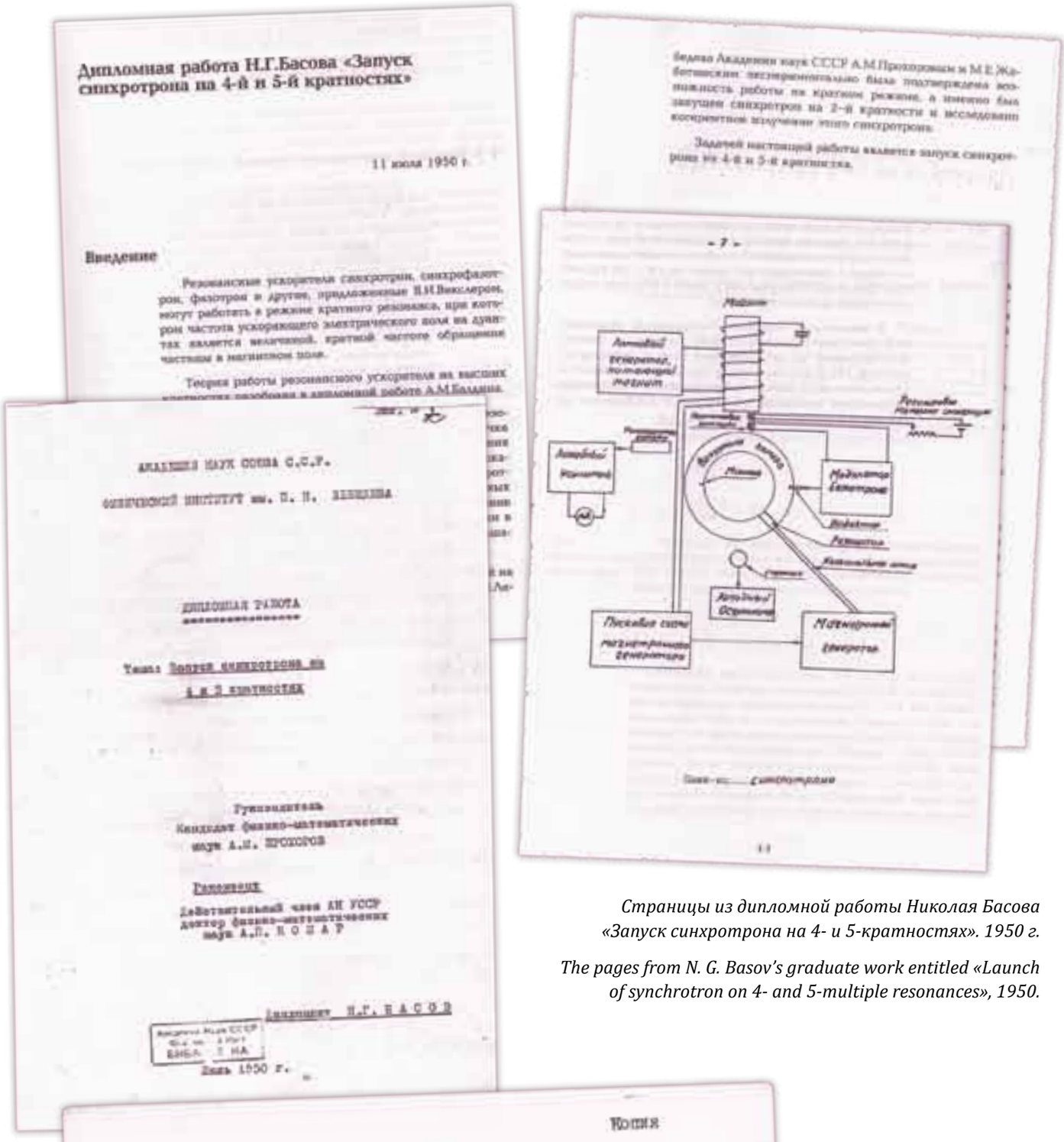
The main task of our Institute today, as we understand it and as set before us by our Government and the Academy, is to do everything possible to promote the development of new ideas and new directions in physics. We worked in the same key in the post-war years. *(N. G. Basov)*

WISE LEADERSHIP

I would like to highlight the post-war research at FIAN, in particular the work of academician D. V. Skobeltsyn, who studied cosmic rays. The flow of energy from space was called the rays, but these are not rays, but a stream of particles. These particles were discovered by Skobeltsyn with the help of a Wilson chamber placed in a magnetic field. Academician G. S. Landsberg did discover the combinational scattering of light *(Raman scattering – ed. remark)*, and academician P. A. Cherenkov discovered a new type of radiation, which is now called by his name. There were many skeptical remarks about this radiation.

Now we can appreciate how wise the Vavilov's approach was. It helped to develop these areas of physics. One can name a number of other researches carried out at FIAN.

This list naturally includes all works on quantum electronics and masers, which were developing at that time. It is the broad approach to them as to oscillatory and nonlinear systems, allowed one to solve a lot of fundamental issues. *(N. G. Basov)*



Дипломная работа Н.Г.Басова «Запуск синхротрона на 4-й и 5-й кратностях»

11 июля 1950 г.

Введение

Резонансные ускорители синхротрон, синхрофазотрон, фазотрон и другие, предложенные В.И.Векслером, могут работать в режиме кратного резонанса, при котором частота ускоряющего электрического поля на дуантах является величиной, кратной частоте обращения частицы в магнитном поле.

Теория работы резонансного ускорителя на высших кратностях изложена в дипломной работе А.М.Балдина.

АКАДЕМИЯ НАУК СОЮЗА С.С.Р.

ФИЗИЧЕСКИЙ ИНСТИТУТ им. П. Н. ЛЕБЕДЕВА

ДИПЛОМНАЯ РАБОТА

Тема: Запуск синхротрона на 4 и 5 кратностях

Руководитель
Кандидат физико-математических
наук А.М. ПРОХОРОВ

Выполнил
Действительный член АН УССР
доктор физико-математических
наук А.М. БОНЧ-БРУЕВИЧ

Дипломант Н.Г. БАСОВ

Москва 1950 г.

- 7 -

Копия

ДИПЛОМ с ОТЛИЧИЕМ В № 003640

Предъявитель сего тов. БАСОВ Николай Геннадиевич в 1946 г. поступил и в 1950 г. окончил полный курс инженерно-физического факультета МОСКОВСКОГО МЕХАНИЧЕСКОГО ИНСТИТУТА по специальности ПРОЕКТИРОВАНИЕ и ЭКСПЛОАТАЦИЯ ФИЗИЧЕСКИХ ПРИБОРОВ и УСТАНОВОК и решением Государственной Экзаменационной Комиссии от 14 июля 1950 г. ему присвоена квалификация ИНЖЕНЕРА-ФИЗИКА

ПРЕДСЕДАТЕЛЬ ГОСУДАРСТВЕННОЙ ЭКЗАМЕНАЦИОННОЙ КОМИССИИ /подпись/

ДИРЕКТОР /подпись/ СЕКРЕТАРЬ /подпись/

Город Москва июль 1950 г. Регистрационный № 90

Гербовая печать: МОСКОВСКИЙ МЕХАНИЧЕСКИЙ ИНСТИТУТ

Страницы из дипломной работы Николая Басова «Запуск синхротрона на 4- и 5-кратностях». 1950 г.

The pages from N. G. Basov's graduate work entitled «Launch of synchrotron on 4- and 5-multiple resonances», 1950.

Копия диплома Н. Г. Басова об окончании Московского механического института (в будущем МИФИ). 1950 г.

Copy of N. G. Basov's graduation diploma of Moscow Mechanical Institute (MEPhI in future), 1950.

Н. Г. Басов и А. М. Прохоров. *N. G. Basov and A. M. Prokhorov.*

Когда в лабораторию Прохорова пришёл дипломник Н. Г. Басов, Прохоров убедил директора ФИАНа ввести для Басова в лаборатории ещё одну штатную единицу, а за это обещал предоставить свой синхротрон для исследований по другому научному направлению. В ФИАНе говорили, что Прохоров обменял синхротрон на Басова, а Прохоров шутил, что Басов достался ему очень дорого.

When graduate student N. G. Basov came to Prokhorov's laboratory, Prokhorov persuaded the director of FIAN to introduce for Basov one more staff unit, and for this he promised to provide his synchrotron for research in other problems. At FIAN, they said that Prokhorov exchanged the synchrotron for Basov, and Prokhorov himself joked that he got Basov for a very high price.

FIAN POSTGRADUATE STUDENT

After graduating from the Moscow Engineering Physics Institute in 1950, I entered a postgraduate course in theoretical physics, where my scientific advisor was Mikhail Aleksandrovich Leontovich. Of course, it is not so easy to choose your own way in science. After all, discoveries are usually made during comprehensive research of global physical problems. And in order to waste less time on off-topic work, you need to be able to clearly set tasks for yourself. It was not easy for me to start with such famous physicists as Leontovich and Prokhorov.

In those years, we, young physicists, began our research in a new field of physics – molecular spectroscopy. This was the beginning of our close collaboration with Alexander Mikhailovich Prokhorov and our joint research in quantum electronics. My first scientific work was devoted to the study of nuclear moments by radio spectroscopic methods. *(N. G. Basov)*

The extract from the order appointing N. G. Basov to the position of engineer at FIAN, 1950.

г.Москва. 20 декабря 1950г.

§ 8.

Зачислить БАСОВА Н.Г. перевести на должность инженера с 16.XII-50г. с окладом 1400 рублей в месяц.

Основание: Служебная записка Заведующего лабор.А.М.ПРОХОРОВА и рез.Зам.Директора ФИАН М.Г.КРЕЙНИССОВА.

– М.Г.

Верно:

OUR OWN APPROACH

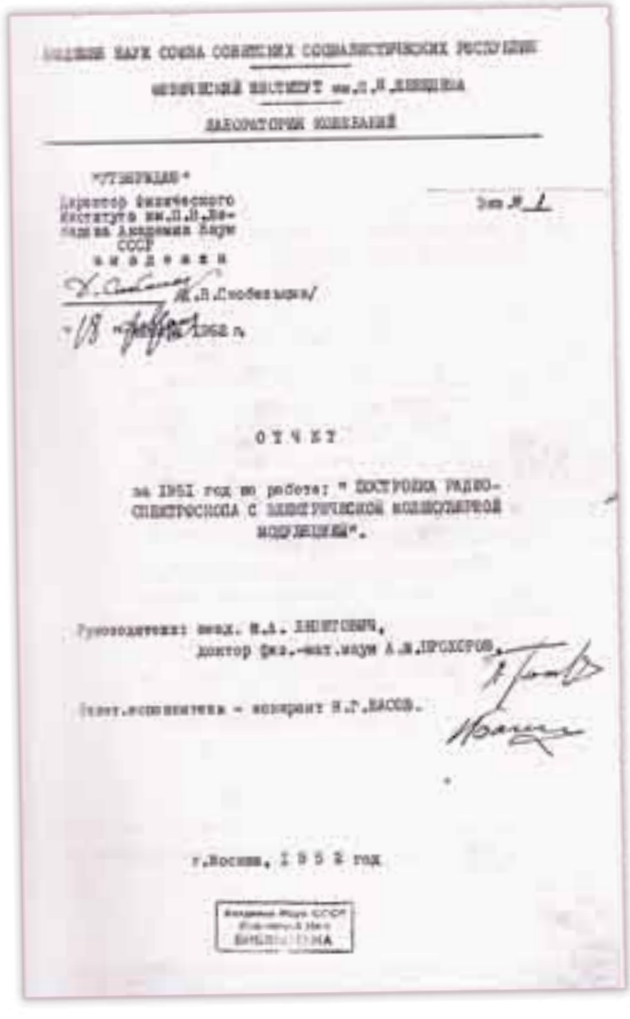
Our aim was to develop such radiation sources which could continuously cover a wide range of centimeter waves. That is why we studied synchrotron radiation. This was necessary for studying the atmosphere, various substances and their behavior in the centimeter wavelength region. The spirit of war was not present in the laboratory. I'm a little younger than Alexander Mikhailovich. He was also in the army, and during the war, both he and me were not engaged in radio engineering studies. Therefore, we were not researchers of radars. And in this regard, we and the American scientists have slightly different approaches to the development of quantum electronics. *(N. G. Basov)*

BRILLIANT EXPERIMENTALIST

From the first days of his work at FIAN, Basov showed himself as a brilliant experimentalist, he wrote bold and profound papers on radio spectroscopy. This allowed him to successfully defend his Ph. D. thesis entitled «Definition of nuclear moments by radio spectroscopic method». *(A. Borovik)*

ACCIDENT

Nikolai Gennadievich had another poisoning, already at FIAN in 1954, when during a laboratory experiment there was an explosion of some poisonous gas or liquid. He was taken by ambulance to the Obukh Institute of professional diseases. All this, of course, could not but affect his health. *(K. T. Basova)*

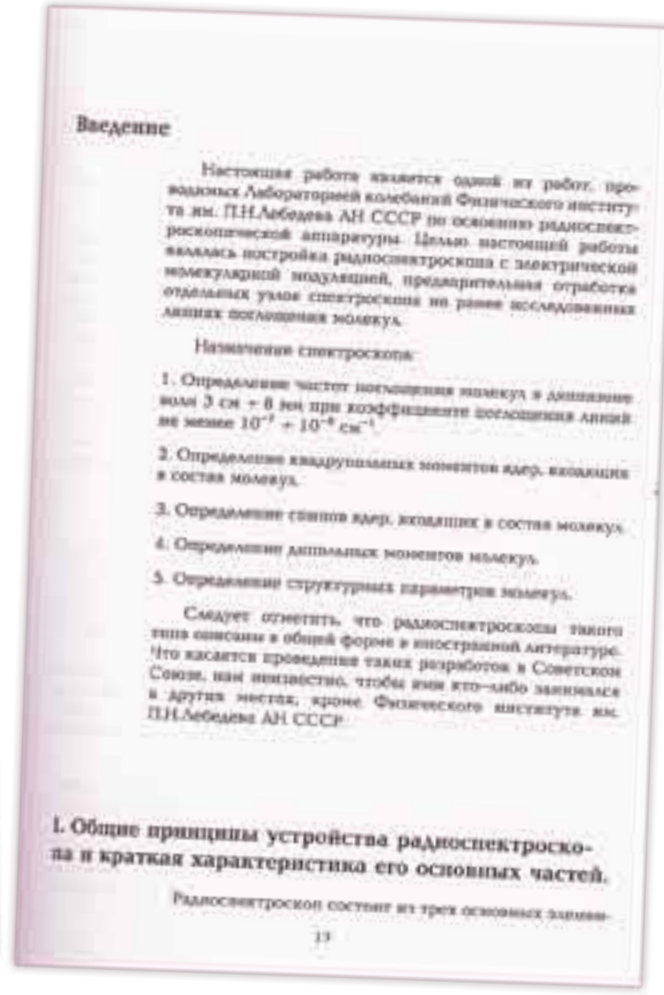


ОТЧЕТ

за 1951 год по работе: " ПОСТРОЙКА РАДИОСПЕКТРОСКОПА С ЭЛЕКТРИЧЕСКОЙ МОЛЕКУЛЯРНОЙ МОДУЛЯЦИЕЙ".

г.Москва, 1952 год

Отчёт аспиранта Н. Г. Басова о проделанной в 1951 году работе по теме «Постройка радиоспектроскопа с электрической молекулярной модуляцией». 1952 г.



Введение

Настоящая работа является одной из работ, проводимых Лабораторией колебаний Физического института им. П.Н.Лебедева АН СССР по освоению радиоспектроскопической аппаратуры. Целью настоящей работы являлась постройка радиоспектроскопа с электрической молекулярной модуляцией, предварительная отработка отдельных узлов спектроскопа на ранее исследованных линиях поглощения молекул.

Назначение спектроскопа:

1. Определение частот поглощения молекул в диапазоне волн 3 см ÷ 8 мм при коэффициенте поглощения линий не менее $10^{-7} \div 10^{-6}$ см$^{-1}$.

2. Определение квадрупольных моментов ядер, входящих в состав молекул.

3. Определение спинов ядер, входящих в состав молекул.

4. Определение дипольных моментов молекул.

5. Определение структурных параметров молекул.

Следует отметить, что радиоспектроскопы такого типа описаны в общей форме в иностранной литературе. Что касается проведения таких разработок в Советском Союзе, нам неизвестно, чтобы ими кто-либо занимался в других местах, кроме Физического института им. П.Н.Лебедева АН СССР.

I. Общие принципы устройства радиоспектроскопа и краткая характеристика его основных частей.

Радиоспектроскоп состоит из трех основных элемен-

13

The report of post-graduate student Basov on the work done in 1951 on the topic «Construction of a radio spectroscope with electrical molecular modulation», 1952.

OUTSTANDING DISCOVERY IN PHYSICS

In 1952, Nikolai Gennadievich Basov made a speech at a meeting of the Academy of Sciences Presidium, where, on his own behalf and on behalf of A. M. Prokhorov, he presented the results of a theoretical analysis of a new principle of generation and amplification of electromagnetic waves, based on the induced emission of electromagnetic quanta by excited quantum systems. Subsequently, there were developed the devices on the basis of this principle which were called masers and lasers. It is unlikely that those who listened the report fully realized that the results presented by Basov should become the basis of one of the most outstanding discoveries in physics of the 20th century. Those results were included in the famous article by N. G. Basov and A. M. Prokhorov that was published in the Journal of Experimental and Theoretical Physics (JETP) in 1954. *(A. N. Oraevsky)*

FOR ME COHERENCE WAS MOST DIFFICULT OF ALL

The richness and abundance of ideas, diversity and breadth of various technologies in allied sciences, the search for something physically new – what gave more incentive? It was quite simple: the development was from the simple to the more complex. When there appeared the principle of optical feedback in systems with a negative temperature – its feasibility gave rise to no doubts, although it was difficult to find the simplest possible physical system, i. e., ammonia. There became possible superconducting resonators, regenerative feedback with additional electronic amplifiers or molecular beams occupying almost completely the solid angle. Most difficult of all for me was coherence. Why should generation (we called the system a quantum generator) emit monochromatic oscillations? The width of the spectral line – the interaction time with the field – would inevitably lead to the width of the emission line. Almost no one among the people surrounding me (including very prominent theorists) apprehended the concept of stationarity under conditions of a flow of molecules, both in the number of molecules and in the number of photons, leading to a monochromacity. *(N. G. Basov)*

FIRST PAPER ON QUANTUM ELECTRONICS

The theory of nonlinear oscillations has been very actively studied in the Oscillation laboratory.

The forerunners of these studies were academicians L. I. Mandelstam, N. D. Papaleksi, corresponding-member S. M. Rytov, and many colleagues of the laboratory working in this field. At a conference on radio spectroscopy, we reported on the possibility of self-excitation as applied to a CsF molecule. During the discussion, there was a question from the conference hall:

Why not ammonia? (Ammonia was a classic substance in radio spectroscopy.) We answered, that ammonia can also be used, but it requires slightly different conditions than CsF: we had a cylindrical condenser, but one should use another sorting system. That's how it was. A. M. Prokhorov and I wrote a paper in JETP – it was at the beginning of 1953. And when the paper was ready to be published we found an error in writing the numerical coefficients of self-excitation conditions: 2π to some power was missing. This made us take the paper from the journal for revision.

We had our paper published only a year later, after sending it to the editor for the second time. Now it was dated 1954, and entered the editorial office in December, 1953 (NG Basov, AM Prokhorov, «Application of molecular beams for radio-spectroscopic study of rotational spectra of molecules». JETP, 1954, vol. 27, No. 4).

Before the paper was published, a very interesting discussion about one more question had taken place. The masers haven't operated yet, and we raised the question of whether the radiation of molecules in the cavity due to the intrinsic field should be coherent. We discussed it in detail with many colleagues of FIAN including the members of the Theoretical department.

We spent many hours discussing this matter with Prof. V. Ya. Fainberg. I also discussed it with academician L. D. Landau. The question turned out to be not trivial. We assumed that the radiation would be completely monochromatic, the width of the emission bandwidth will tend to zero if the self-excitation condition is satisfied. This question seemed completely clear to us, to prove it we had our ideas about physical processes. However, whoever we discussed that issue with, all gave a negative answer to it: the radiation linewidth will be the same as the spectral linewidth.

The research on the resonator self-excitation by a beam of molecules was repeatedly discussed at different seminars of the Moscow State University, FIAN, and other places. This paper can be called the first publication on quantum electronics. In addition, we wanted very much to observe the phenomena occurring at molecular generation. It took some time to develop a dispersion theory for the molecular

beams, taking into account the saturation effect and, on its basis, write equations for a molecular oscillator. A relevant paper appeared – «The theory of a molecular oscillator and a molecular power amplifier», which was also jointly prepared with A. M. Prokhorov. This second Soviet paper on quantum electronics was reported at a conference of the Faraday Society in England. I think those two papers were fundamental for a further development of quantum electronics. In general, a huge role in the rapid development of quantum electronics was played by a whole atmosphere of high scientific culture typical of the Oscillation laboratory of FIAN. In the laboratory and at the Institute one could easily get any advice and assistance with devices, obtain useful and critical remarks from colleagues on any problem.

It seems to me that there was no better place than FIAN for such a research in the Soviet Union. In this sense, we were very lucky. It was the atmosphere of a very appropriate approach to a solution of a scientific problem. It did not let our imagination go very far away. And on the other hand, it turned our fantasy into equations that were solved, and experimental installations that soon supported our theoretical predictions.

I would say these were particularly favorable conditions and atmosphere for scientific research, which were created due to the director of FIAN, academician S. I. Vavilov, and then were actively supported and developed by his successor – the director of FIAN academician D. V. Skobeltsyn. *(N. G. Basov)*

FROM RADIO-SPECTROSCOPE TO MASER

The possibility of using stimulated emission of quantum systems to create a microwave generator was reported for the first time by N. G. Basov at the conference on the magnetic moments of the nuclei. The conference chaired by Academician D. V. Skobeltsyn, the then director of the Institute, was held in 1953 at the P. N. Lebedev Physics Institute (FIAN) of the USSR Academy of Sciences. The report was kept for many years in the archives and was printed in the book «Notes of an Archivist», published at the FIAN in 1997. Apparently, Nikolai Gennadievich was the first to raise this issue. In those years, N. G. Basov worked in the field of radiofrequency spectroscopy of molecules at the FIAN laboratory headed by A. M. Prokhorov. Interestingly, the incentive to use stimulated emission instead of absorption arouse from the need to increase the resolution of the radio-frequency spectroscope while recording the fine and hyperfine structure of the spectra of molecules in the radio range. *(O. N. Krokhin)*

BAPTIZING OF QUANTUM ELECTRONICS

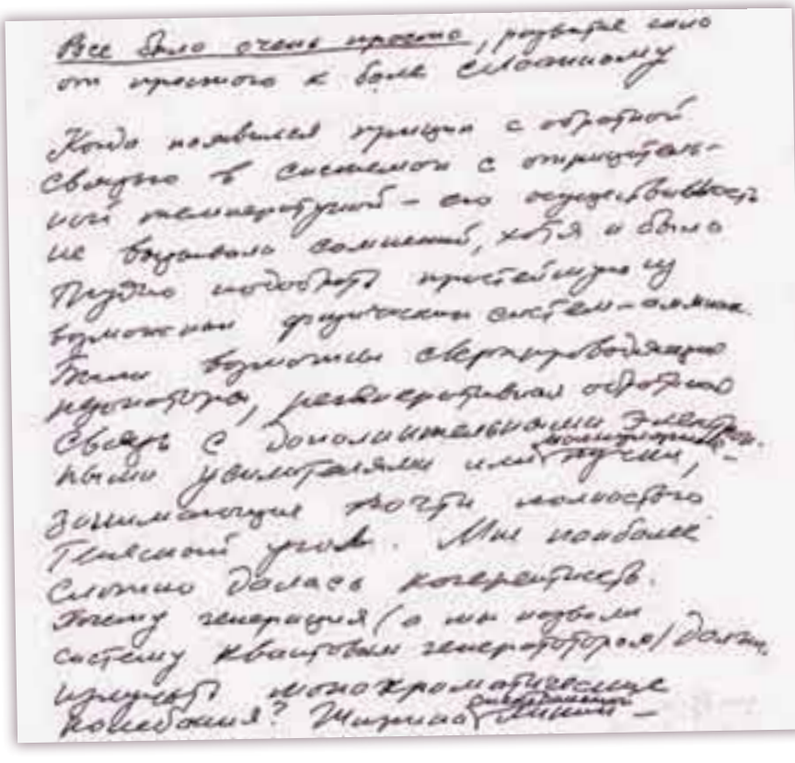
There is a lot of literature on the history of quantum electronics. And we always remember the year 1954, when the first quantum oscillator (maser) was invented in the USSR and the USA.

This was preceded, of course, by numerous discussions and reports. I had an opportunity to hear a report made by Nikolai Gennadievich at the Polytechnic Museum, May 1952, devoted to the prospects of a quantum oscillator. As I remember now – it was a beautiful sunny day, and we drove up to the Polytechnic Museum by tram. There, in a small hall, the All-Union conference on radio-spectroscopy was held, where Nikolai Gennadievich was one of the speakers. After the report, numerous questions followed, there was a heated discussion, many people expressed bewilderment and misunderstanding. Academician V. A. Kotelnikov was the chairman. Closing the meeting, he said: «Comrades, we are witnessing the birth of a new science – quantum electronics.» Since I am also a physicist by education, those words literally stuck in my memory.

P. S. There is a mention of this event in the book by V. A. Kotelnikov «The fate that embraced the century», volume 2. (K. T. Basova)

Отрывок из рукописи Н. Г. Басова.

Extract from N. G. Basov's manuscript.



Выписка

из протокола № 7 заседания Совета Московского инженерно-физического института

от 14 декабря 1953 г.

ПРИСУТСТВОВАЛО: 26 членов Совета из 36 утвержденных ВАК при Министерстве Культуры СССР.

СЛУШАЛИ: 1. Защиту диссертации на соискание ученой степени кандидата физико-математических наук аспиранта БАСОВА Николая Геннадиевича на защиту при личном участии официальных оппонентов – доктора физико-математических наук профессора Смородинского Якова Абрамовича и доктора физико-математических наук профессора ЛАНДАУ Семена Шмидтовича.

ПОСТАНОВИЛИ: Присудить аспиранту БАСОВУ Николаю Геннадиевичу ученую степень кандидата физико-математических наук на основе защиты диссертации.

Результаты баллотировки: на Совете института присутствовало 26 членов Совета из 36 утвержденных ВАК при Министерстве Культуры СССР:

За – 25
против – нет
воздержа. – 1

(Подлинник протокола хранится в делах Совета института).

ПРЕДСЕДАТЕЛЬ СОВЕТА
Директор института (К.ШАЛЬНИКОВА)

УЧЕНЫЙ СЕКРЕТАРЬ СОВЕТА
доцент (А.ЗАХАРОВ)

Выписка из протокола о присвоении Н. Г. Басову учёной степени кандидата физико-математических наук.

Extract from the protocol on awarding the scientific degree of the Candidate (PhD) of Physical and Mathematical Sciences to N. G. Basov.

Копия

МИНИСТЕРСТВО КУЛЬТУРЫ СССР
ВЫСШАЯ АТТЕСТАЦИОННАЯ КОМИССИЯ

ДИПЛОМ КАНДИДАТА НАУК

МВ-СМ № 000058

Москва 31 марта 1954 г.

Решением

СОВЕТА МОСКОВСКОГО ИНЖЕНЕРНО-ФИЗИЧЕСКОГО ИНСТИТУТА от 14 декабря 1953 г. /протокол № 7/

Н А С О В У Николаю Геннадиевичу

ПРИСУЖДЕНА УЧЕНАЯ СТЕПЕНЬ КАНДИДАТА ФИЗИКО-МАТЕМАТИЧЕСКИХ НАУК

ПРЕДСЕДАТЕЛЬ СОВЕТА /подпись/
УЧЕНЫЙ СЕКРЕТАРЬ СОВЕТА /подпись/

Гербовая печать: МОСКОВСКИЙ ИНЖЕНЕРНО-ФИЗИЧЕСКИЙ ИНСТИТУТ

3 февраля 1955 г. Нотариус

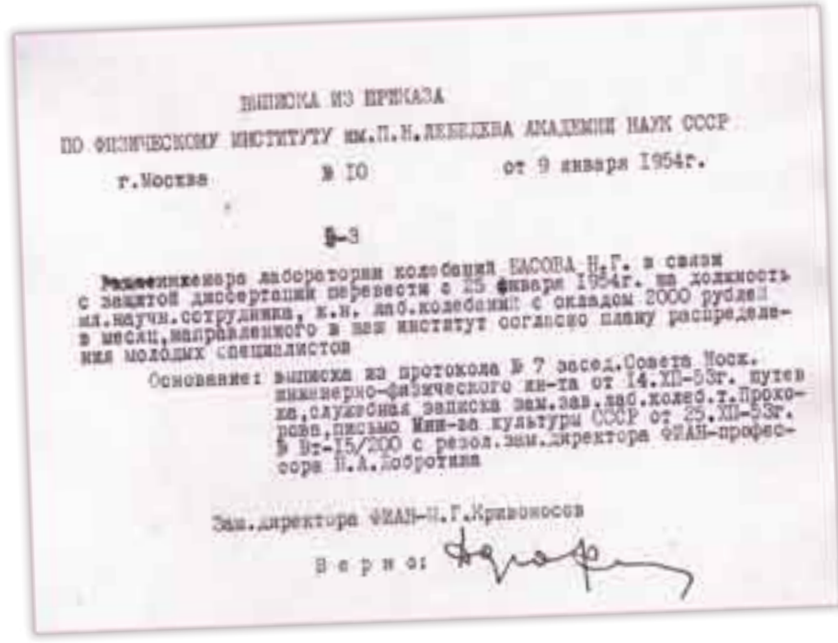
Диплом о присуждении научной степени кандидата физико-математических наук Н. Г. Басову. 1953 г.

Diploma on awarding the scientific degree of candidate (PhD) of physical and mathematical sciences to N. G. Basov, 1953.

«NAIL AND STRING» DEVICE

Now, when I read or hear that to achieve scientific success one needs special conditions, I remember that Ph. D. thesis and the doctoral dissertation *(there are two scientific ranks in the USSR and Russia: Candidate of Sciences equaled to PhD and Doctor of Sciences – ed. remark)* were written by Nikolai, one might say, on the edge of the table.

Of course, time has moved far ahead, and now success very often depends on good equipment. But in those days it was believed (by definition of the academician A. F. Ioffe) that a good experimenter should be able to make a device even out of nail and string. *(K. T. Basova)*



ВЫПИСКА ИЗ ПРИКАЗА

ПО ФИЗИЧЕСКОМУ ИНСТИТУТУ им.П.Н.ЛЕБЕДЕВА АКАДЕМИИ НАУК СССР

г.Москва № 10 от 9 января 1954г.

§-3

Инженера лаборатории колебаний БАСОВА Н.Г. в связи с защитой диссертации перевести с 25 января 1954г. на должность мл.научн.сотрудника, к.н. лаб.колебаний с окладом 2000 рублей в месяц,направленного в наш институт согласно плану распределения молодых специалистов

Основание: выписка из протокола № 7 засед.Совета Моск. инженерно-физического ин-та от 14.XII-53г. путевка,служебная записка зам.зав.лаб.колеб.т.Прохорова,письмо Мин-ва культуры СССР от 29.XII-53г. № Вт-15/200 с резол.зам.директора ФИАН-профессора П.А.Добротина

Зам.директора ФИАН-Н.Г.Кривоносов

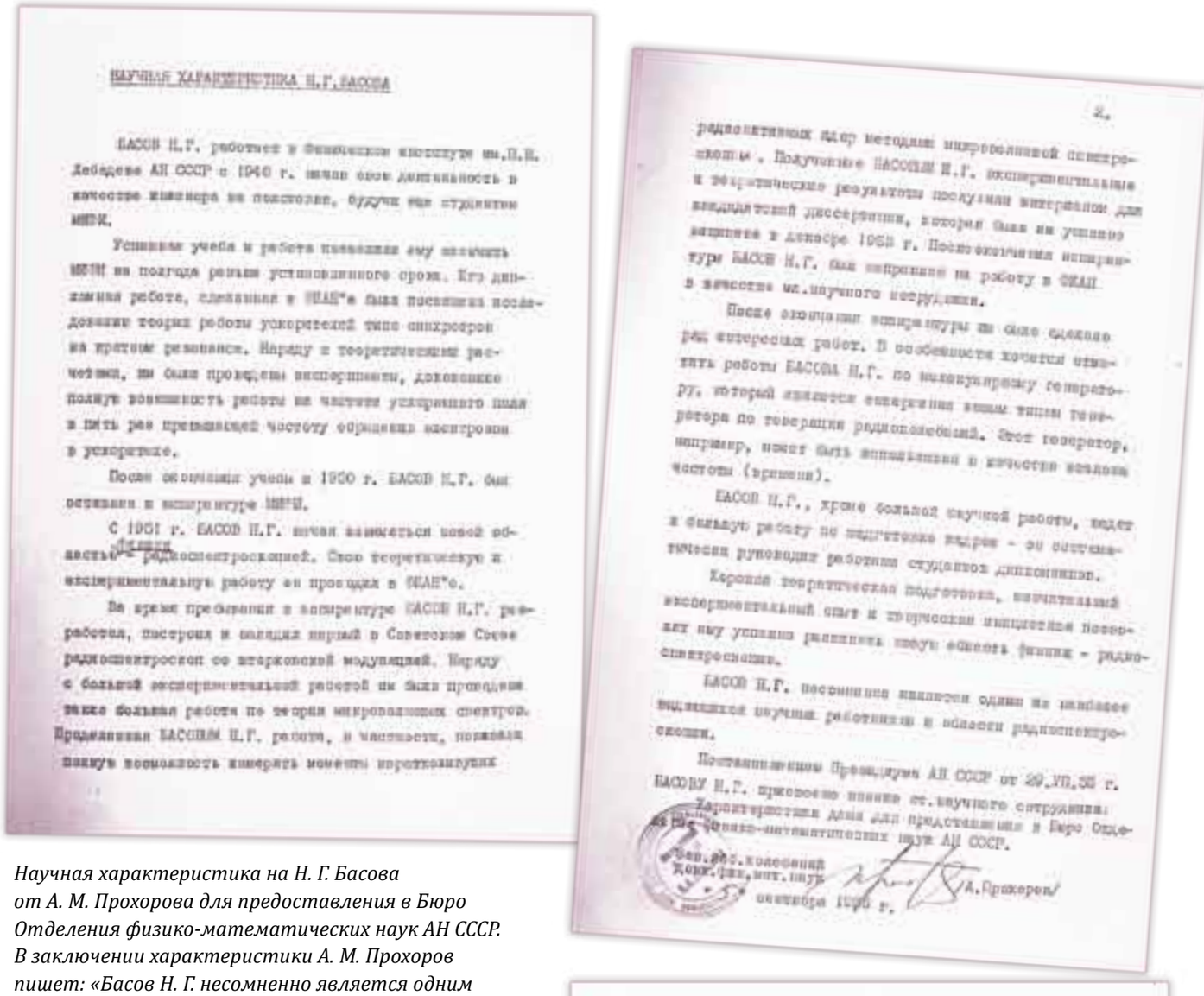
Верно:

Выписка из приказа о присвоении Н. Г. Басову должности младшего научного сотрудника. 1954 г.

Extract from the order on assignment of the position of a junior researcher to N. G. Basov, 1954.

Николай Геннадиевич Басов и Александр Михайлович Прохоров.

Nikolai Gennadievich Basov and Aleksandr Mikhailovich Prokhorov.



НАУЧНАЯ ХАРАКТЕРИСТИКА Н.Г.БАСОВА

БАСОВ Н.Г. работает в Физическом институте им.П.Н. Лебедева АН СССР с 1948 г. после своей деятельность в качестве инженера на полигоне, будучи еще студентом МИФИ.

Успешная учеба и работа позволили ему получить МИФИ по полугоду раньше установленного срока. Его дипломная работа, сделанная в ФИАН'е была посвящена исследованию теории работы ускорителей типа синхротронов на третьем резонансе. Наряду с теоретическими расчетами, на ней были проведены эксперименты, доказавшие полную возможность работы на частоте ускоренного пучка в пять раз превышающей частоту обращения электронов в ускорителе.

После окончания учебы в 1950 г. БАСОВ Н.Г. был оставлен в аспирантуре МИФИ.

С 1951 г. БАСОВ Н.Г. начал заниматься новой областью радиоспектроскопией. Свою теоретическую и экспериментальную работу он проводил в ФИАН'е.

За время пребывания в аспирантуре БАСОВ Н.Г. разработал, построил и сделал первый в Советском Союзе радиоспектроскоп со встроенной модуляцией. Наряду с большой экспериментальной работой им была проведена также большая работа по теории микроволновых спектров. Предложенная БАСОВЫМ Н.Г. работа, в частности, позволила полную возможность измерять моменты короткоживущих

2.

радиоактивных ядер методами микроволновой спектроскопии. Полученные БАСОВЫМ Н.Г. экспериментальные и теоретические результаты послужили материалом для кандидатской диссертации, которая была им успешно защищена в декабре 1953 г. После окончания аспирантуры БАСОВ Н.Г. был направлен на работу в ФИАН в качестве мл.научного сотрудника.

После окончания аспирантуры им было сделано ряд интересных работ. В особенности хочется отметить работы БАСОВА Н.Г. по молекулярному генератору, который является совершенно новым типом генератора по генерации радиоколебаний. Этот генератор, например, может быть использован в качестве эталона частоты (времени).

БАСОВ Н.Г., кроме большой научной работы, ведет и большую работу по подготовке кадров - он систематически руководит работами студентов дипломников.

Хорошая теоретическая подготовка, значительный экспериментальный опыт и творческая инициатива позволяют ему успешно решать такую сложную задачу - радиоспектроскопии.

БАСОВ Н.Г. несомненно является одним из наиболее выдающихся научных работников в области радиоспектроскопии.

Постановлением Президиума АН СССР от 29.VII.55 г. БАСОВУ Н.Г. присвоено звание ст.научного сотрудника.

Характеристика дана для представления в Бюро Отделения физико-математических наук АН СССР.

Зав.отд.колебаний
Физ.ин.им.Лебедева
сентября 1955 г.

/А.Прохоров/

Научная характеристика на Н. Г. Басова от А. М. Прохорова для предоставления в Бюро Отделения физико-математических наук АН СССР. В заключении характеристики А. М. Прохоров пишет: «Басов Н. Г. несомненно является одним из наиболее выдающихся научных работников в области радиоспектроскопии». 5 сентября 1955 года.

Scientific records of N. G. Basov from A. M. Prokhorov for the presentation to the Bureau of the Physical and Mathematical Sciences Department of the USSR Academy of Sciences. In conclusion, A. M. Prokhorov writes: «Basov N. G. is undoubtedly one of the most outstanding scientists in the field of radiospectroscopy». September 5, 1955.

Копия

СССР
МИНИСТЕРСТВО [illegible] ОБРАЗОВАНИЯ
ВЫСШАЯ АТТЕСТАЦИОННАЯ КОМИССИЯ

АТТЕСТАТ СТАРШЕГО НАУЧНОГО СОТРУДНИКА

МИФ № 000286

Москва 15 августа 1955г.

Решением Президиума Академии Наук Союза Советских Социалистических Республик от 29 июля 1955г./ протокол № -/ БАСОВ НИКОЛАЙ ГЕННАДИЕВИЧ УТВЕРЖДЕН В УЧЕНОМ ЗВАНИИ СТАРШЕГО НАУЧНОГО СОТРУДНИКА ПО СПЕЦИАЛЬНОСТИ "РАДИОФИЗИКА"

Председатель
Президент Академии Наук - подпись
Главный Ученый Секретарь
Президиума Академии Наук - подпись

Гербовая печать Академии Наук СССР.

27 декабря 1955 г. [illegible]

[illegible] Московской Государственной Нотариальной конторы, свидетельствую верность этой копии с подлинником.

[illegible]

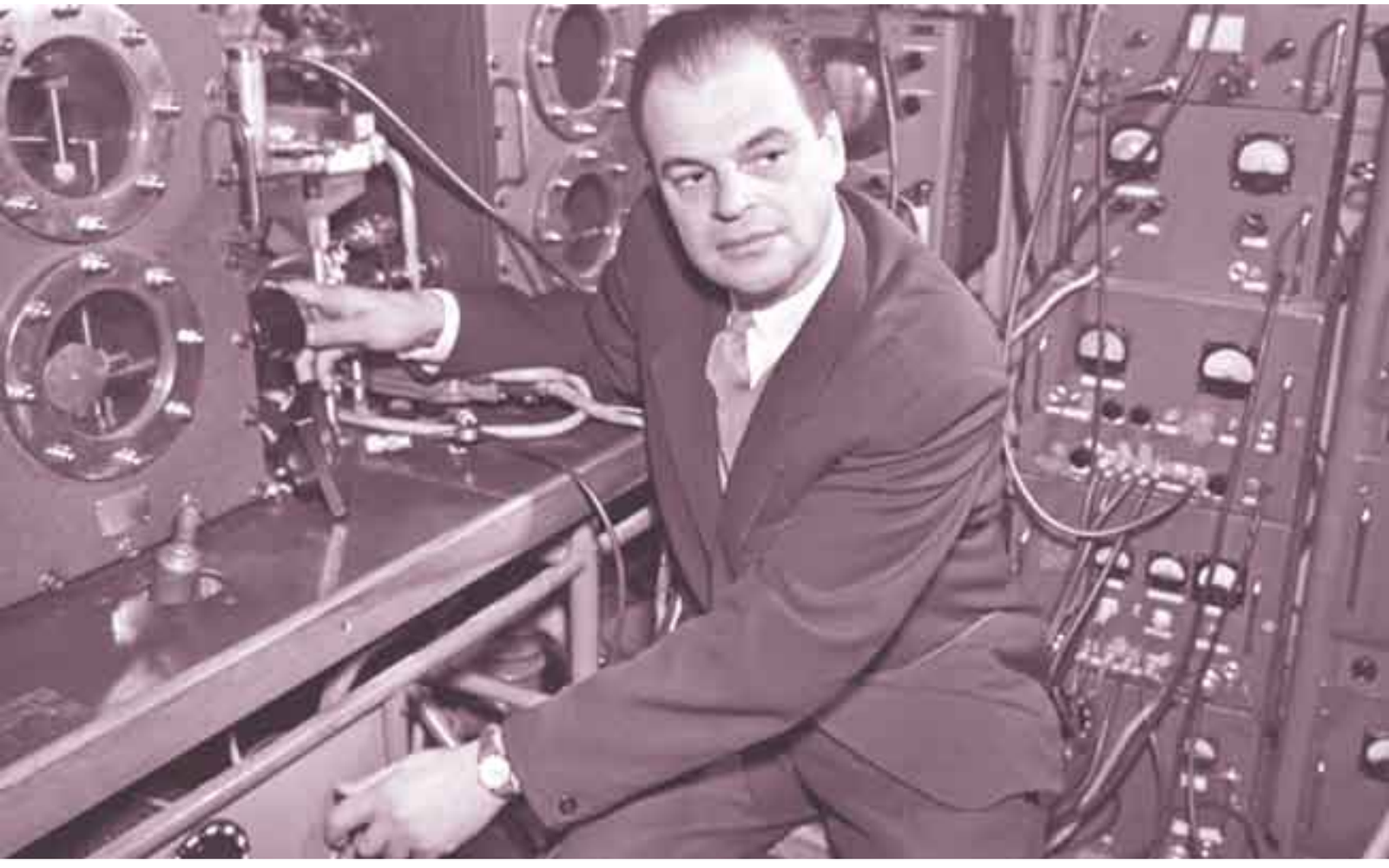
Нотариус [illegible]

Примечание: "Председатель" не читать

Нотариус [illegible]

Утверждение Н. Г. Басова Президиумом АН СССР в звании старшего научного сотрудника. 29 июля 1955 г.

Approval of N. G. Basov in the rank of a senior researcher by the Praesidium of the USSR Academy of Sciences, July 29, 1955.



Н. Г. Басов во время лабораторных исследований.

N. G. Basov in the laboratory.

A BIG SHIP HAS A GREAT VOYAGE

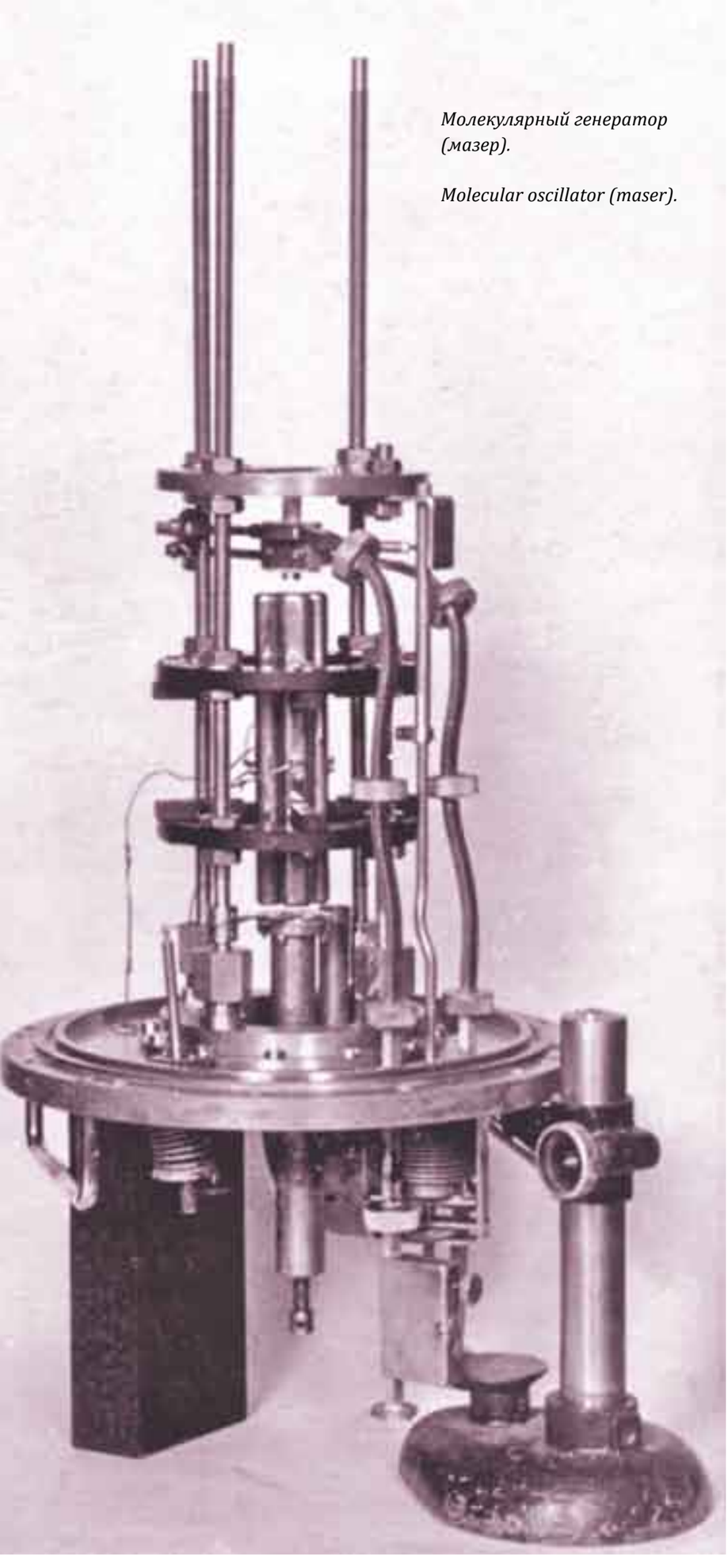
I met Nikolai Gennadievich Basov in 1953, when I came to FIAN for undergraduate and diploma practice in the Oscillations laboratory. He was appointed a supervisor of my work and that of my fellow student K. K. Svidzinsky. Naturally, we wanted to know what kind of person he was, after all, Basov was then a young scientist who had just received his Ph. D. We were extremely satisfied with the high scientific reputation of Nikolai Gennadievich among the laboratory staff. In FIAN, they recognized in him the future great scientist.

It is significant that on the day he defended his Ph. D. thesis, the laboratory staff presented him with a beautiful briefcase, on which they attached a bar with the inscription: «Big ship – great sailing.» They were not mistaken…

My collaboration with K. K. Svidzinsky was at that time very close, and we often had frank conversations, in which we also talked about our chief. Basov was full of scientific ideas – it was his most impressive feature for us. After the summer vacation, we knew for sure that we would meet Basov filled with new, unexpected scientific thoughts. *(A. N. Oraevsky)*

Доктор физико-математических наук А. Н. Ораевский.

Doctor of Sciences in Physics and Math (Prof.) A. N. Oraevsky.



Молекулярный генератор (мазер).

Molecular oscillator (maser).

Первый экспериментальный мазер был изготовлен в трёх экземплярах.

The first experimental maser was made in triplicate.

INSPIRED BY THE ROMANTIC SPIRIT OF SCIENCE

The doctoral dissertation of Nikolai Gennadievich was called «Molecular oscillator», that is, a maser. It was 1956 – six years have passed after graduation from the Institute. Life was full of hard work and insights. Romantic appeal of science inspired me too – and after the birth of our first son, Gennady – it led me to postgraduate studies. The topic of my dissertation was dealing with semiconductor compounds, and Nikolay Gennadievich had to be interested in semiconductors. Many people said that even if I do my thesis myself, no one will believe it, anyway. However, as an excuse, I want to say that my research was experimental and took place within the walls of the Kurchatov Institute. But after it, my so-called scientific activity came to an end because of the birth of our second son Dmitry, and I had no time for science, although remained a teacher at MEPhI. *(K. T. Basova)*

DOCTOR DISSERTATION

N. G. Basov and his co-workers constructed technically advanced molecular oscillators of electromagnetic waves (masers), experimentally confirmed the dependence of oscillation frequencies on the molecular beam intensity, and other factors. Molecules of ammonia gas were used as the working substance. Methods for the oscillator frequency tuning were developed, and using the ammonia line one achieved, for the first time, the stability of the radiation frequency with accuracy up to the eleventh decimal sign. Experimental studies were summarized in the works of 1955–1956, and the initial results of a newly developed method for generation and amplification of electromagnetic radiation were reported in Basov's doctoral dissertation «Molecular oscillator», 1956. *(E. A. Avdyusheva, R. A. Milovanova)*

Н. Г. Басов – работа над рукописью.

N. G. Basov writing a manuscript.

«THE NEW AND THE GREAT ARE BORN IN PAIN»

I don't remember a more dramatic dissertation defense than that of the Basov's thesis. Now it seems incomprehensible that the work, which was later awarded the Lenin and Nobel Prizes, had got such mixed, although ultimately positive reviews. Remember the old truth: the new and the great are born in pain. *(A. N. Oraevsky)*

Первая страница докторской диссертации Н. Г. Басова «Молекулярный генератор». 1956 г.

The first page of N. G. Basov's doctoral dissertation entitled «A molecular oscillator», 1956. («A molecular generator» in Russian – ed. remark)

АКАДЕМИЯ НАУК СОЮЗА СОВЕТСКИХ СОЦИАЛИСТИЧЕСКИХ РЕСПУБЛИК

ФИЗИЧЕСКИЙ ИНСТИТУТ им.П.Н.ЛЕБЕДЕВА

Н.Г.Басов

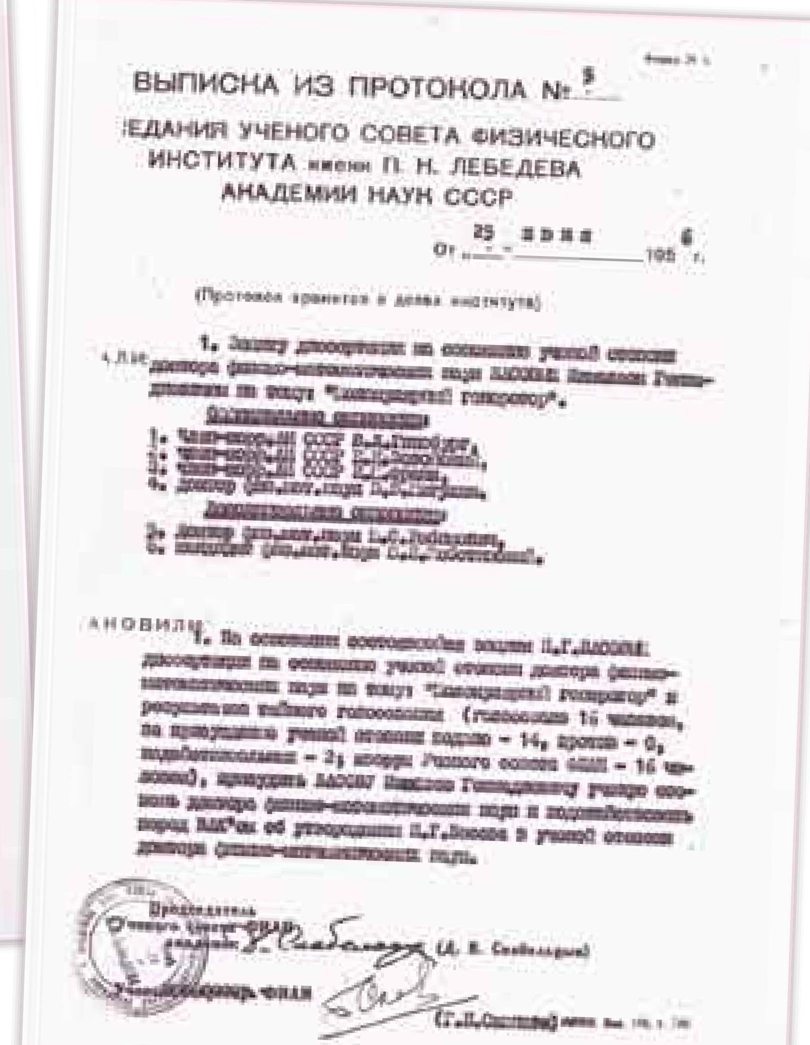
МОЛЕКУЛЯРНЫЙ ГЕНЕРАТОР

Диссертация на соискание ученой степени доктора физико-математических наук.

г.Москва – 1956 год.

Выписка из протокола о голосовании за присуждение Н. Г. Басову учёной степени доктора физико-математических наук. 25 июня 1956 г.

Extract from the voting protocol for awarding N. G. Basov the degree of Doctor of Sciences in Physics and Math., June 25, 1956.



ВЫПИСКА ИЗ ПРОТОКОЛА № 5

ЗАСЕДАНИЯ УЧЕНОГО СОВЕТА ФИЗИЧЕСКОГО ИНСТИТУТА имени П. Н. ЛЕБЕДЕВА АКАДЕМИИ НАУК СССР

От 25 июня 1956 г.

(Протокол хранится в делах института)

Review on the work of N. G. Basov «Molecular oscillator»

December 21, 1955

The work of N. G. Basov «Molecular oscillator» presented by him as a doctoral thesis is the result of a four – year work done by him on the theoretical substantiation and experimental implementation of a molecular oscillator. The possibility of creating a molecular oscillator was first shown by N. G. Basov in 1952. In the first chapter of the work, basing on the quantum theory of dispersion with account for the saturation effect, a theory of the steady-state operation of a molecular oscillator and a molecular amplifier has been developed. Possible methods for obtaining «active» molecules are considered. In the same chapter, an interesting idea is put forward about a feasibility of making a molecular oscillator without using a molecular beam. Basing on theoretical calculations, a monochromaticity and high stability of oscillations has been proved, which, in particular, should make it possible to use the molecular oscillator as a high-accuracy frequency (time) etalon.

In the second chapter, a theory is presented on the operation of individual units of the molecular oscillator using a beam of ammonia (NH3) molecules, and the construction of the molecular oscillator is given. In the same chapter, the results are reported, which are in a good agreement with theoretical calculations.

Both the theoretical part and experimental parts of the work, and each of them separately, are of great value, and any of these parts could be presented as a doctoral thesis.

I believe that N. G. Basov, due to his scientific qualifications, is certainly worthy of the degree of Doctor of Sciences in Physics and Mathematics.

Prof. A. M. Prokhorov
Head of the Oscillations laboratory

Review on N. G. Basov's Thesis «Molecular oscillator»

June 18, 1956

«Doctoral Thesis of N. G. Basov is devoted to the experimental and theoretical research of a new, interesting and important physical device – a molecular oscillator.

Physical principles underlying this device are clearly reported in the introduction to this work, and it would be inappropriate to repeat them here. I would just restrict myself to a remark that it seems typical of N. G. Basov to comprehend the physical picture of the phenomena before doing the experiment, which allowed him to go, as a rule, the shortest path to the goal. As far as I know, a group of American physicists ran into this idea of a molecular oscillator just accidentally-while studying the operation of another device. And Basov first of all put forward the idea of the device itself.

Then together with A. M. Prokhorov, they developed an idea of a molecular oscillator. This theory is simple and still needs to be developed, but it is adequate, in the first approximation, and is sufficient for constructing and fixing the

Review on N. G. Basov's thesis «Molecular oscillator» submitted for the degree of Doctor of Sciences in Physics and Math

June 22, 1956

device. On this basis, Basov succeeded in building a molecular oscillator in a very short time, and studied the most important aspects of its operation. <…>

The author not only achieved a success (by constructing a new and valuable physical device), and he achieved it not by chance, but quite deservedly.

The remarks made cannot, of course change the high assessment of the work of N. G. Basov, who, on the basis of the presented thesis, deserves to be awarded the Doctor of Sciences in Physics and Mathematics degree.

V. L. Ginzburg
Corresponding member
USSR Academy of Sciences

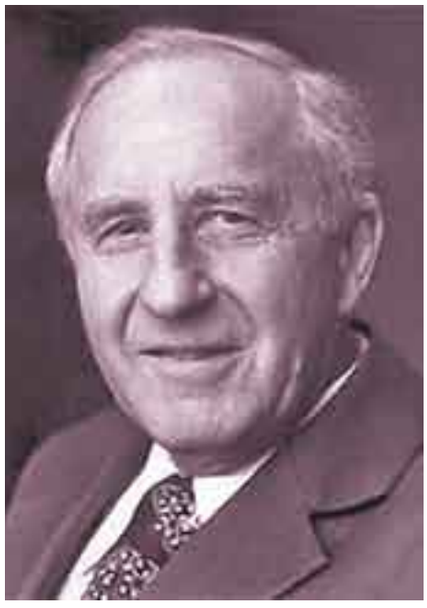
The idea of creating a molecular oscillator was first proposed by the author in 1952. Later, at the end of 1954, Gordon, Zeiger, and Townes described very interesting experiments with this type of an oscillator. The interest to the molecular oscillator is due to the fact that it makes it possible to obtain highly monochromatic oscillations and can be used as a very precise radio-spectroscope. High frequency stability of the molecular oscillator will, apparently, make it possible to carry out experiments on laboratory verification of the general theory of relativity in respect of the influence of the Earth's gravitational field on the speed of time. At present, Basov and Prokhorov have developed a fairly rigorous and complete theory of the molecular oscillator, which has been largely confirmed by the author's experiments and the works of Gordon, Zeiger, and Townes.

<…> Of great interest is the Basov's and Prokhorov's idea of a «sealed-off» oscillator and amplifier. Bringing such systems to practical implementation will make it possible to use them widely in practice and carry out many new and important physical investigations. <…>

<…> N. G. Basov's thesis is a major scientific work that opens up new opportunities in the field of scientific and practical applications of radio-spectroscopy. <…>

Based on the foregoing, I believe that the work of N. G. Basov fully satisfies all the requirements to doctoral dissertations, and N. G. Basov deserves the Doctor of Sciences in Physics and Mathematics degree.

E. K. Zavoisky
Corresponding Member
USSR Academy of Science



Review on Basov's thesis «Molecular oscillator»

June 6, 1956

The work of N. G. Basov entitled «Molecular oscillator» and presented as a doctoral dissertation is a very serious research of many aspects related to the implementation of a new, extremely interesting device that is of fundamental importance for radiophysics. Already in 1952, the author first pointed out the possibility of creating a molecular oscillator, and later, he independently and jointly with A. M. Prokhorov, carried out great physics research that led him to the implementation of a working device.

The dissertation highlights those main questions, the resolution of which led the author to the successful completion of an important stage of the research. And this work in its significance goes far beyond the scope of solution of a particular experimental problem. Not to mention the importance of creating a source of radio frequency oscillations with extraordinary stability, far exceeding the stability of all devices known so far. During the development of a molecular oscillator there were solved interesting and important theoretical and experimental problems.

This is an independent and original work, and the results obtained are more rigorous and complete than those obtained and published by Gordon, Zeiger and Townes, as well as published elsewhere.

<…> A systematic and complete analysis of all the main processes occurring in a molecular oscillator makes this work a very valuable and extensive study.

<…> There are no doubts about author's interesting thoughts concerning a creation of a «sealed-off» oscillator.

<…>There were found successful solution to many issues (pumping, quadrupole capacitor protection from excess beam, beam injection into cavity through the limiting waveguide, and others), and there was well-thought-out study of operation of the acting molecular oscillator. All this speaks of Basov's maturity as a physicist who successfully combines experimental skill with a deep analysis of the phenomena being studied.

Evaluating all the work as a whole, it must be recognized that the coverage a wide range of theoretical and experimental research, which led the author to creation of a molecular oscillator is of significant interest for physics and engineering, and has great prospects for further development. N. G. Basov proved to be an experienced and widely erudite scholar, who combines fluency in theory and experimental skill, and he quite deserves to be awarded the Doctor of Sciences in Physics and Mathematics degree.

Professor V. V. Migulin

Review on N. G. Basov's thesis «Molecular oscillator»

June 12, 1957

The thesis outlines fundamentals of a theory for a new physical device – a «molecular oscillator», as well as experiments on implementation and study of the oscillator operation. N. G. Basov is the author of the main idea of this device dealing with quantum transitions between molecular levels to be used for excitation of high-frequency oscillations in hollow cavities.

Thus, it becomes possible to develop a natural frequency standard of extremely high stability and accuracy (unattainable by other methods).

This original and witty idea in N. G. Basov's researches (partially performed jointly with A. M. Prokhorov) received not only theoretical support and development, but the experimental implementation as well, which is most essential.

The dissertation provides a detailed presentation of the molecular oscillator theory based mainly on the author's own work.

The influence of various factors on the generation frequency was considered, the theory of molecular amplifier was developed, the operation of the oscillators on gas was theoretically studied, etc.

A complete calculation of all elements of the oscillator was performed, its design was described, and the results of an experimental study of the main parameters characterizing the device operation (frequency stability, generated power, etc.) were presented. Theory was found to be in a good agreement with experiment.

The works performed by N. G. Basov and included in the dissertation under review are characterized by a high level of theoretical analysis of complex physical problems that we encounter when trying to clarify the main physical processes occurring in such an unusual radio engineering system using the quantum properties of measurement.

At the same time, author's skills as an experimentalist are at a very high level too. He managed to overcome a large number of various difficulties encountered on the way of molecular oscillator development.

Thus, it can be stated that the author of the dissertation, both in terms of the significance of the scientific results obtained by him, and in terms of his scientific qualifications, undoubtedly deserves to be awarded the degree of Doctor of Sciences in Physics and Mathematics degree.

Academician
L. A. Artsimovich

Review
on the Basov's Thesis
«Molecular oscillator»,

June 1956.

A new method has been developed for producing continuous oscillations by using the stimulated emission of molecules. This is in many respects a remarkable method for oscillation generation, called by the author «the molecular oscillator», which was implemented and studied experimentally.

Obtaining a frequency standard determined by inherent properties of atoms or molecules, has attracted more and more attention, in recent years.

Relevance of this task is evident. Some time ago a similar problem of finding a length standard emerged and was solved, i. e. comparing a meter with the light wavelength. However, the length standard exists and it can be only a periodic or even one-time comparison of this etalon with a physical constant, the light wavelength.

The situation is different with measurement of time. We don't have a clock being as perfect as may be needed for solving certain tasks.

Therefore, a more complex problem arises here – the development of new «atomic» or «molecular» clocks.

Of no less interest is an inverse problem, i. e. the exact measurement of the atomic and molecular spectral frequencies lying in the field of radio frequencies. From both of these viewpoints, the molecular oscillator is of considerable interest and has clear prospects to further application. Note that physical phenomena occurring in such a oscillator are quite peculiar and not at all elementary.

All this makes Basov's Thesis very interesting not only for specialists in oscillation physics but for physicists of other specialties, including, in particular, the author of this review.

At the same time, the Thesis deserves a detailed examination. First of all, I want to note that it is written very well, and the presentation is so clear and comprehensive that can be understood by any physicist, including those who are not specialists in this field.

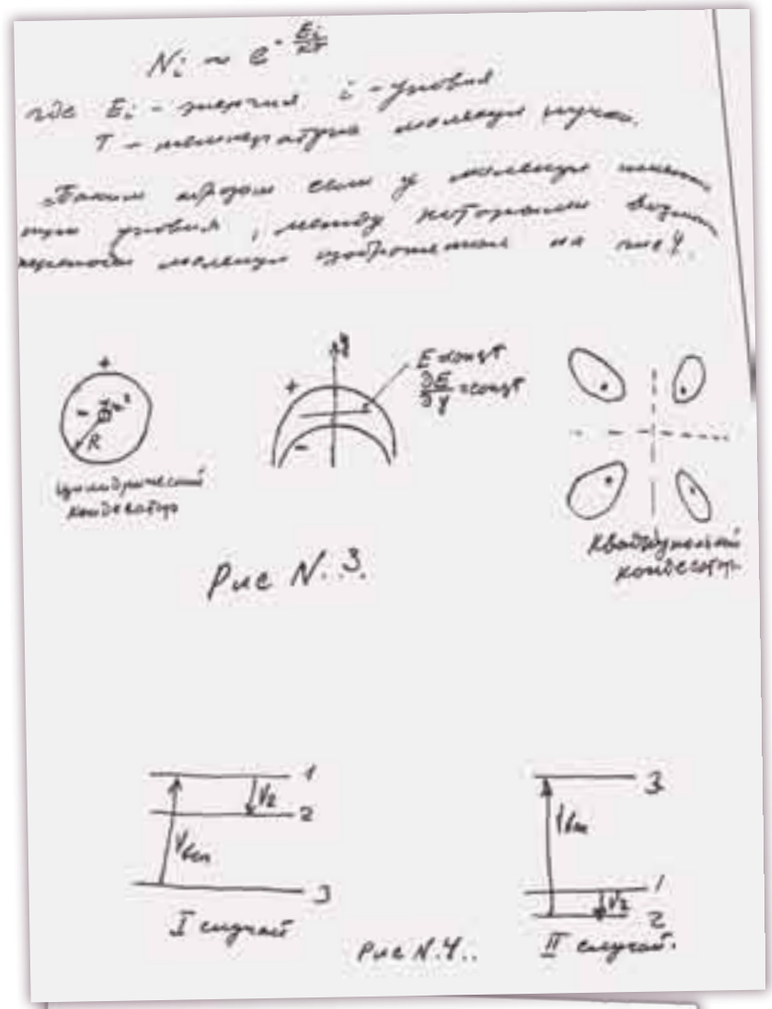
<…> I may note that although the derivation of particular formulas is very clear, and the nature of approximations and admissions made is seen everywhere, the initial provisions to the theory are discussed insufficiently, in my opinion.

At the same time, by comparing the theory developed by N. G. Basov with the results of a foreign paper, the author quoted in the final paragraph of his Thesis, one can argue that the theoretical consideration carried out by the author is much more perfect than that done by other physicists.

A few words about the experimental part of the work, on which I have no comments. You don't need to be a specialist to understand that the author has solved a difficult experimental problem, and that this part of the work also deserves very high marks. The fact that the experimental study of the oscillator has not yet been fully completed cannot be considered a flaw in the dissertation. The main thing was clarified, and it was shown that the oscillator actually possesses the properties that are predicted by the theory developed in the Thesis.

Текст и рисунки Н. Г. Басова к тезисам доклада Н. Г. Басова и А. М. Прохорова «Молекулярный генератор», прочитанного Н. Г. Басовым на заседании Всесоюзного научного общества радиотехники и радиосвязи им А. С. Попова, октябрь 1954 г.

Text and drawings by N. G. Basov to the abstract of the report by N. G. Basov and A. M. Prokhorov «Molecular oscillator» presented by N.G.Basov at a meeting of the All-Union A. S. Popov Scientific Society of Radio Engineering and Radio Communication, October 1954.



Among a number of issues that are studied in the experimental part of the work, the author considers the effect of molecular beam intensity on the frequency that is being generated.

The author says that it may improve the tuning of the oscillator. If so, it might be useful, perhaps, to consider experimentally the influence of the resonator Q-factor on the frequency.

All the remarks I made are concerned with problems, which in my opinion, did not receive a complete solution in the Thesis. I paid so much attention to them not because I see any serious defects in work. On the contrary, it is because the work seems to me extremely interesting, and therefore it is desirable to understand better the whole range of issues that are associated with it.

I believe that on the basis of what has been said, N. G. Basov should undoubtedly be awarded the degree of Doctor of Sciences in Physics and Math.

I. M. Frank
Corresponding member of the
USSR Academy of Sciences

Выписка об утверждении Н. Г. Басова в учёной степени доктора физико-математических наук. 1957 г.

Document confirming N. G. Basov's scientific degree Doctor of Sciences in Physics and Math., 1957.

CHOICE OF DESTINY

When Nikolai Gennadievich Basov became a famous scientist, women immediately began to pursue him. After all, at that time it was prestigious to be the wife of a scientist. Many women envied Kseniya Tikhonovna. And at one press conference, a dialogue took place between Nikolai Gennadievich and one pretty girl.

– Nikolai Gennadievich, how did you meet your wife?

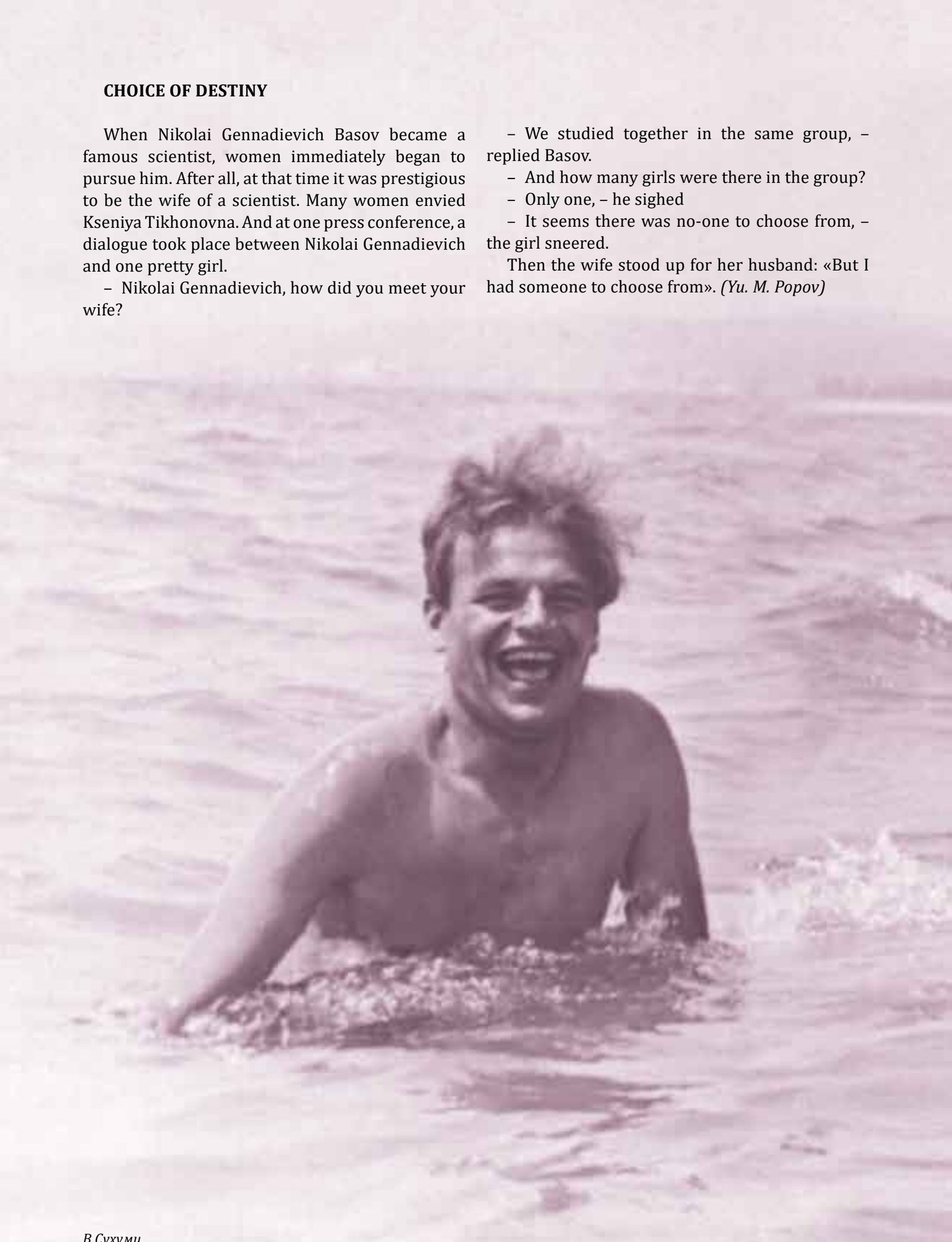
– We studied together in the same group, – replied Basov.

– And how many girls were there in the group?

– Only one, – he sighed

– It seems there was no-one to choose from, – the girl sneered.

Then the wife stood up for her husband: «But I had someone to choose from». *(Yu. M. Popov)*



В Сухуми.

Bathing in the Black Sea, the USSR resort city of Sukhumi.

Супруги Басовы.
Spouses Basovs.

У родителей в Воронеже. Слева направо:
1-й ряд – жена Ксения, сын Геннадий, брат Владимир;
2-й ряд – мать Зинаида Андреевна,
отец Геннадий Фёдорович. В роли фотографа – Н. Г. Басов.
1957 г.

With the parents in Voronezh. Left to right, upper row:
Mother – Zinaida Andreevna, Father – Gennady Fedorovich,
lower row – wife Kseniya, son – Gennady, brother – Vladimir.
N. G. Basov as the photographer, 1957.

Премьер-министр Республики Индии Джавахарлал Неру во время посещения Физического института имени Лебедева АН СССР. Среди присутствующих: М. В. Келдыш, В. С. Вавилов, Н. Г. Басов и П. А. Черенков. 1958 г.

Prime Minister of the Republic of India Jawaharlal Nehru visiting the Lebedev Physical Institute of the USSR Academy of Sciences. Among those present: M. V. Keldysh, V. S. Vavilov, N. G. Basov, and P. A. Cherenkov, 1958.

Визит Джавахарлала Неру в ФИАН. Слева направо: Н. Г. Басов, М. В. Келдыш, Д. Неру, В. С. Вавилов. 1958 г.

The visit of Jawaharlal Nehru to the Lebedev Institute. Left to right: N. G. Basov, M. V. Keldysh, D. Nehru, V. S. Vavilov, 1958.

NUMEROUS GUESTS TO FIAN

After the molecular oscillator started working, we had many guests, from morning to evening, demonstrating oscillation beats between identical oscillators. We were the first to produce beats: three oscillators were made, between two pairs were observed beats, and we studied the stability of the radiation frequency. *(N. G. Basov)*

ARRIVAL OF NIELS BOHR

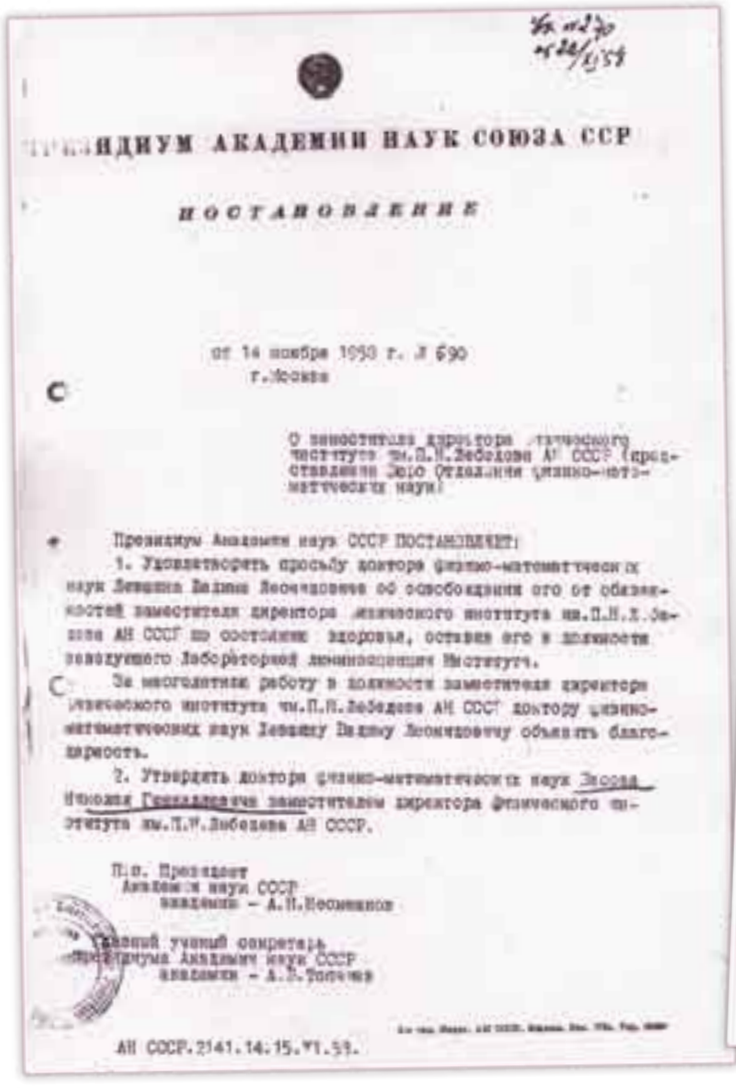
In May 1961, 16 months before his death, the great physicist Niels Bohr made a two-week visit to the USSR. In Moscow, he was three times in FIAN. After a short talk in D. V. Skobeltsyn's *(Director of FIAN – ed. remark)* office, we went to examine some of the laboratories. Bohr was shown an automatic installation for observation of photo-emulsion tracks, the Petukhov's synchrotron of 700 MeV, the Basov's laser facility, the Prokhorov's nucleus orientation setup. Bohr preferred to inspect installations, and not to talk to theoreticians. *(E. L. Feinberg)*

Визит Нильса Бора в ФИАН. Слева направо: Д. В. Скобельцын, Е. Л. Фейнберг, Оге Бор, Нильс Бор, И. Д. Рожанский, Н. Г. Басов. 1961 г.

The visit of Niels Bohr to the Lebedev Institute. Left to right: D. V. Skobeltsyn, E. L. Feinberg, Aage Bohr, Niels Bohr, I. D. Rozhansky, N. G. Basov, 1961.

Слева направо: Николай Басов, Игорь Штраних, Нильс Бор, Георгий Жданов, Дмитрий Скобельцин, Оге Бор около телевизионного микроскопа, который предназначен для просматривания ядерных фотоэмульсий.

Left to right: Nikolai Basov, Igor Shtranikh, Niels Bohr, Georgiy Zhdanov, Dmitry Skobeltsyn, and Aage Bohr – near a television microscope designed for scanning nuclear emulsions.



ПРЕЗИДИУМ АКАДЕМИИ НАУК СОЮЗА ССР

ПОСТАНОВЛЕНИЕ

от 14 ноября 1958 г. № 690
г.Москва

О заместителе директора Физического института им.П.Н.Лебедева АН СССР (представление Бюро Отделения физико-математических наук)

Президиум Академии наук СССР ПОСТАНОВЛЯЕТ:

1. Удовлетворить просьбу доктора физико-математических наук Левшина Вадима Леонтьевича об освобождении его от обязанностей заместителя директора Физического института им.П.Н.Лебедева АН СССР по состоянию здоровья, оставив его в должности заведующего лабораторией люминесценции Института.

За многолетнюю работу в должности заместителя директора Физического института им.П.Н.Лебедева АН СССР доктору физико-математических наук Левшину Вадиму Леонтьевичу объявить благодарность.

2. Утвердить доктора физико-математических наук Басова Николая Геннадиевича заместителем директора Физического института им.П.Н.Лебедева АН СССР.

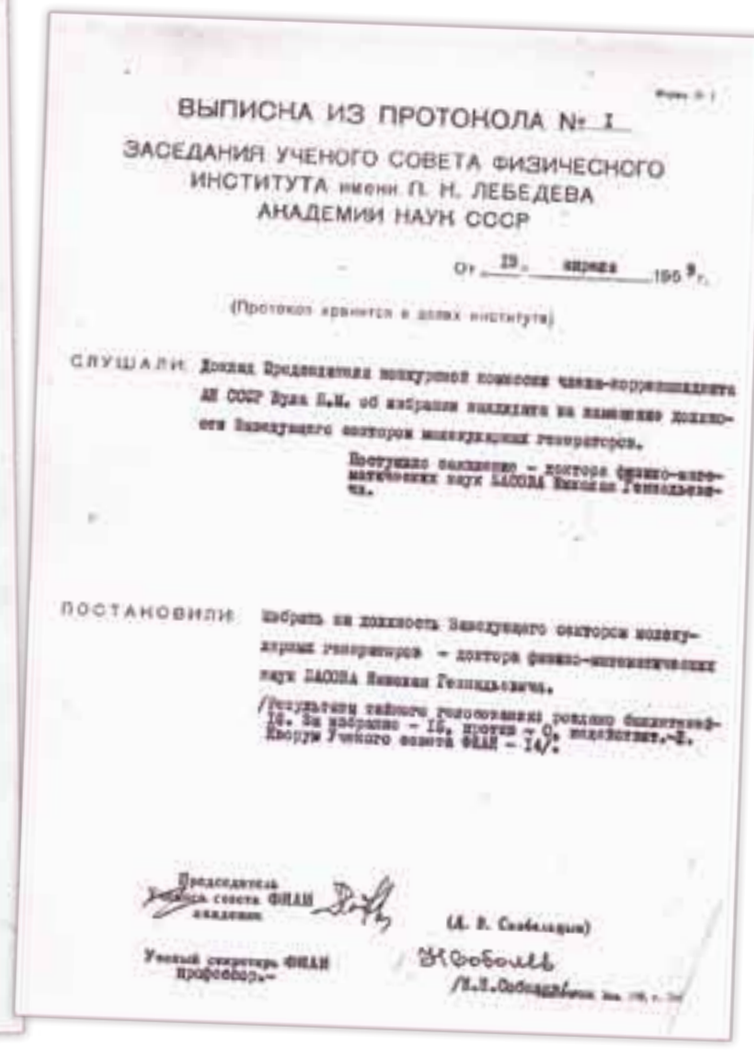
П.о. Президент
Академии наук СССР
академик – А.Н.Несмеянов

Главный ученый секретарь
Президиума Академии наук СССР
академик – А.В.Топчиев

АН СССР.2141.14.15.VI.59.

Постановление об утверждении Н. Г. Басова на должность заместителя директора Физического института им. П. Н. Лебедева. 14 ноября 1958 г.

Resolution on the approval of N. G. Basov for the post of vice-director of the Lebedev Physical Institute, November 14, 1958.



ВЫПИСКА ИЗ ПРОТОКОЛА № 1

ЗАСЕДАНИЯ УЧЕНОГО СОВЕТА ФИЗИЧЕСКОГО ИНСТИТУТА имени П. Н. ЛЕБЕДЕВА АКАДЕМИИ НАУК СССР

От 13 апреля 1959 г.

(Протокол хранится в делах института)

СЛУШАЛИ: Доклад Председателя конкурсной комиссии члена-корреспондента АН СССР Вула Б.М. об избрании заведующего сектором молекулярных генераторов.

Поступило заявление – доктора физико-математических наук БАСОВА Николая Геннадиевича.

ПОСТАНОВИЛИ: Избрать на должность Заведующего сектором молекулярных генераторов – доктора физико-математических наук БАСОВА Николая Геннадьевича.

(Результаты тайного голосования: роздано бюллетеней-14. За избрание – 14, против – 0, недействит.-0. Кворум Ученого совета ФИАН – 14).

Председатель Ученого совета ФИАН академик (А. В. Сахаров)

Ученый секретарь ФИАН профессор (М.Е.Жаботинский)

Выписка из протокола об избрании Н. Г. Басова заведующим сектором молекулярных генераторов. 13 апреля 1959 г.

Protocol of N. G. Basov's election as head of the molecular oscillators (masers) sector, April 13, 1959.

ABOUT STUDENTS AND COLLEAGUES

After defending his doctoral Thesis, Nikolai Gennadievich had got students and colleagues who were engaged in studying the theory of molecular oscillators and experimental research. In 1958, Basov was appointed deputy director of FIAN for research. In 1959, he headed the sector of molecular oscillators of FIAN.

ВЫПИСКА ИЗ ПРОТОКОЛА № 8

Х БЮРО ОТДЕЛЕНИЯ ФИЗИКО-МАТЕМАТИЧЕСКИХ НАУК АН СССР

от 13 мая 1959 г.

182

67.Утверждение д.ф.м.н. БАСОВА Н.Г. в должности зав.сектором. /Представление ФИАН/

Утвердить доктора физико-математических наук БАСОВА Николая Геннадиевича в должности заведующего сектором молекулярных генераторов физического института им.П.Н.Лебедева – по конкурсу.

П.п.Председатель-академик Л.А.Арцимович
Секретарь-к.х.н.А.Н.Лебачев

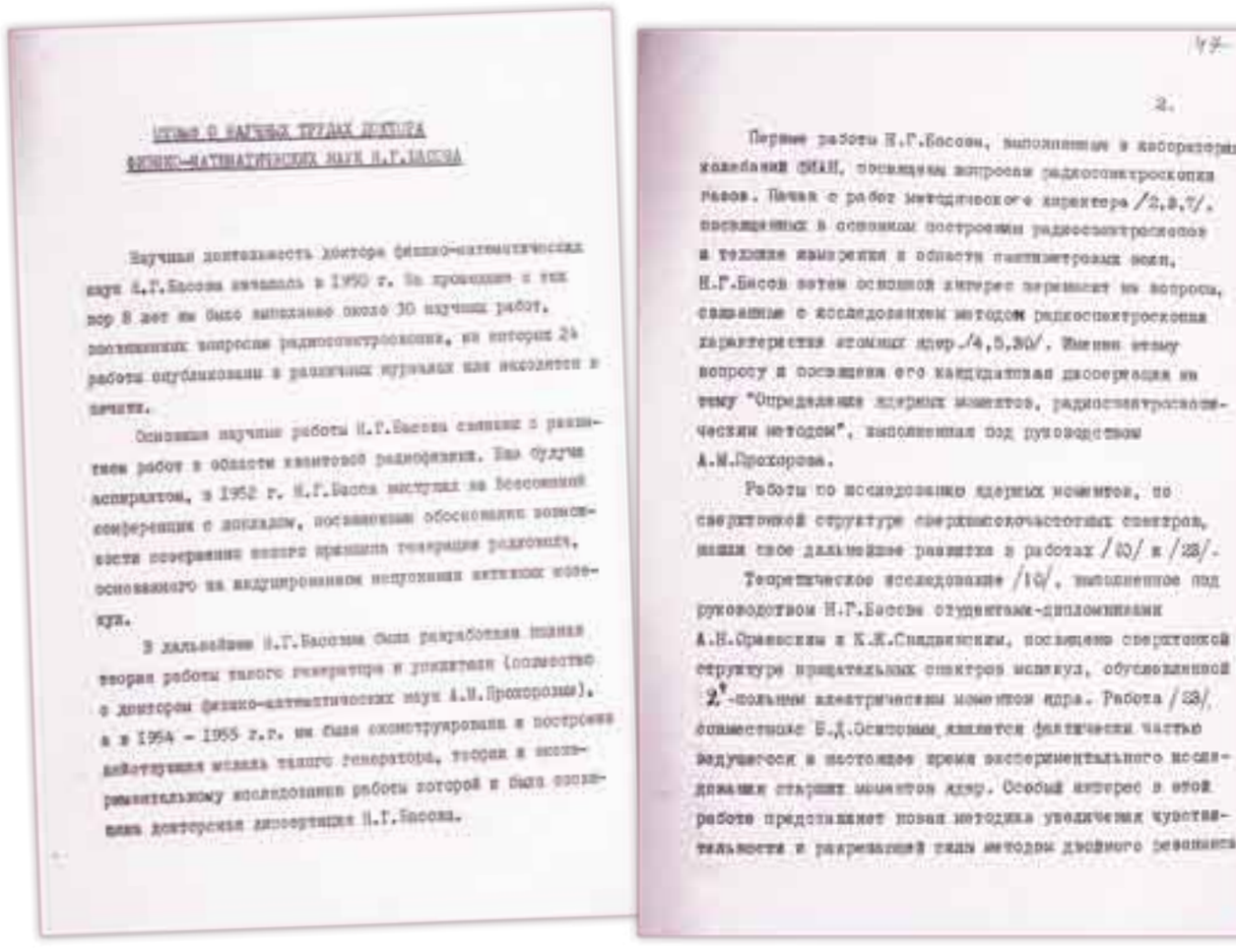
Верно:

2537
20/V
1959

Послано: Президиум – Управ.кадров, ФИАН, Н.Г.Басову.

Выписка из протокола об утверждении Н. Г. Басова заведующим сектором молекулярных генераторов. 13 мая 1959 г.

Protocol of approval of N. G. Basov as head of the molecular oscillators (masers) sector, May 13, 1959.



ОТЗЫВ О НАУЧНЫХ ТРУДАХ ДОКТОРА ФИЗИКО-МАТЕМАТИЧЕСКИХ НАУК Н.Г.БАСОВА

Научная деятельность доктора физико-математических наук Н.Г.Басова началась в 1950 г. За прошедшие с тех пор 8 лет им было выполнено около 30 научных работ, посвященных вопросам радиоспектроскопии, из которых 24 работы опубликованы в различных журналах или находятся в печати.

Основные научные работы Н.Г.Басова связаны с развитием работ в области квантовой радиофизики. Еще будучи аспирантом, в 1952 г. Н.Г.Басов выступил на Всесоюзной конференции с докладом, посвященным обоснованию возможности осуществления нового принципа генерации радиоволн, основанного на индуцированном испускании активных молекул.

В дальнейшем Н.Г.Басовым была разработана полная теория работы такого генератора и указаны (совместно с доктором физико-математических наук А.М.Прохоровым), а в 1954 – 1955 г.г. им были сконструированы и построены действующая модель такого генератора, теория и экспериментальному исследованию работы которой и была посвящена докторская диссертация Н.Г.Басова.

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2.

Первые работы Н.Г.Басова, выполненные в лаборатории колебаний ФИАН, посвящены вопросам радиоспектроскопии газов. Начав с работ методического характера /2,3,7/, посвященных в основном построению радиоспектроскопов и точным измерениям в области сантиметровых волн, Н.Г.Басов затем основной интерес переносит на вопросы, связанные с исследованием методом радиоспектроскопии характеристик атомных ядер /4,5,30/. Именно этому вопросу и посвящена его кандидатская диссертация на тему "Определение ядерных моментов радиоспектроскопическими методом", выполненная под руководством А.М.Прохорова.

Работы по исследованию ядерных моментов, по сверхтонкой структуре сверхвысокочастотных спектров, нашли свое дальнейшее развитие в работах /10/ и /28/.

Теоретическое исследование /10/, выполненное под руководством Н.Г.Басова студентами-дипломниками А.Н.Орловским и К.Н.Спадавинским, посвящено сверхтонкой структуре вращательных спектров молекул, обусловленной 2^{n}-польным электрическим моментом ядра. Работа /28/, совместное Б.Д.Осиповым, является фактически частью ведущегося в настоящее время экспериментального исследования старших моментов ядер. Особый интерес в этой работе представляет новая методика увеличения чувствительности и разрешающей силы методы двойного резонанса.

Review of Dr. N. G. Basov's scientific works.

Обсуждение эксперимента.
Слева направо: А. З. Грасюк, В. Ф. Ефимков, Н. Г. Басов.

Discussion over an experiment.
Left to right: A. Z. Grasyuk, V. F. Efimkov, N. G. Basov.

ASTONISHING INTUITION AND INVENTIVENESS

Basov exhibited an extraordinary broadmindedness and inventiveness in his ideas, and he was notably impatient and persistent in putting them into action. His astonishing intuition and inventiveness, which I witnessed as his graduate student in the 1960s, were infectious for the people in his circle. In his career Basov worked with an enormous number of people and of the 300 or so PhD students that he supervised, about 60 went on to become professors.

As well as having scientific passion and enthusiasm, Basov was also very fair. I still remember a day in 1969 when I told him about an idea I had for using lasers to separate isotopes. I had hoped that we could write a paper together after our discussion. He understood the idea at once, but said that I must publish the work on my own because it would be very important for my career. He did not want to get the credit for the work of his disciples.

In addition to his research, Basov devoted much time to administrative duties and to public office. Indeed, he served at the highest levels: he became director of the Lebedev Institute in 1973 and was also a member of the Supreme Council of the USSR and the Presidium of Academy of Sciences, among other bodies.

This combination of basic research and politics demanded a lot of intellectual, emotional and physical strength. However, the sincerity of Basov's convictions, combined with his honesty and frankness, meant that he made only a few of the mistakes that are inevitable under any centralized political system. The most creative and active people often inspire jealousy in others, and the criticisms of Basov by some scientists appear to me to be inversely proportional to their own ability. *(V. S. Letokhov)*

THE WORK OF A SCIENTIST

The process of creativity starts when you, knowing your subject well enough, can already see what you don't know and what you don't know how to do. This is the starting point of your future contribution to science. What do you want to do for it, what new things you discovered for yourself, for society. Unfortunately, today it is impossible to know everything, so you have to choose what to be and what to do. This is a difficult decision to make for any man at the very beginning of life – in his youth.

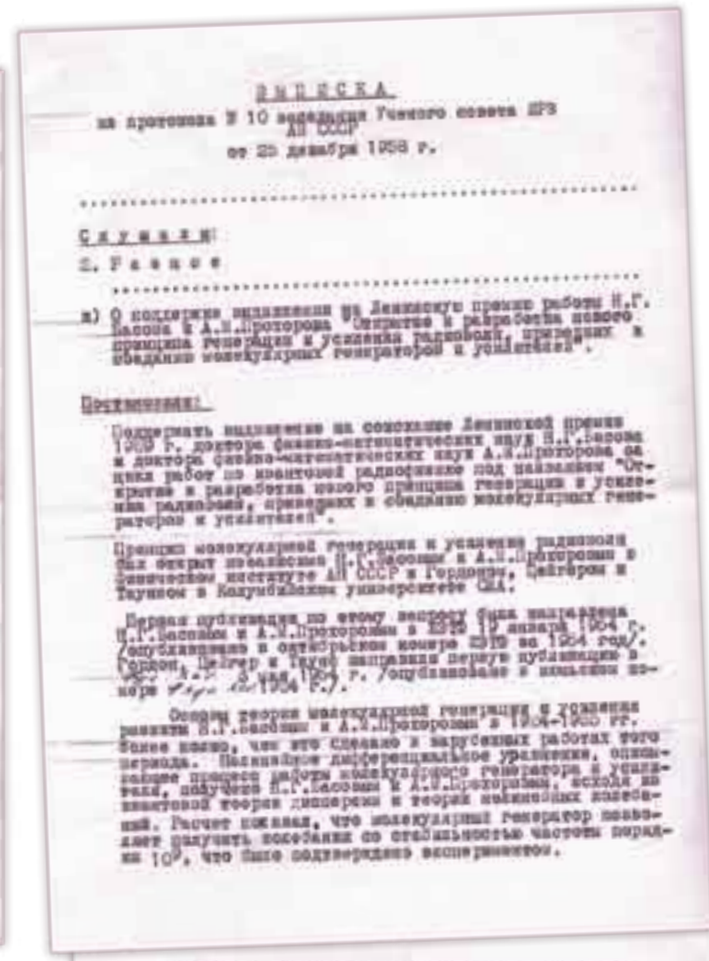
Of course, it is not so easy to choose a profession. If this is a work of a scientist, then outline for yourself the first topics of your independent studies, to which you could then dedicate your life. Much here, of course, depends on talent and human inclinations. *(N. G. Basov)*

NON-STANDART SCIENTIFIC MENTALITY

L. V. Keldysh told me at one of the official events (having no reason to do so) that he considered Basov's thinking completely unusual (perhaps unexpected) and highly appreciated it. Then he added: "… like Feynman's». Another episode. A. M. Prokhorov, at Basov's funeral at FIAN, spoke about Basov-a student, who came for practice to his group: "… and suddenly he began to walk saying that a molecule is a device, like a radio circuit. It can amplify, something else… We decided that he, you see, went crazy». Later, N. A. Irisova, one of A. M. Prokhorov's employees, spoke about the same episode, but in other terms, on TV. Thus, prominent scientists who knew N. G. Basov well recognized his non-standard scientific thinking. *(A. V. Vinogradov)*

В обеденный перерыв – на волейбольную площадку в ФИАНе.

During the lunch break – to the volleyball court at FIAN.



Представление Н. Г. Басова и А. М. Прохорова на соискание Ленинской премии 1959 г. 25 декабря 1958 г.

Nomination of N. G. Basov and A. M. Prokhorov for the Lenin Prize 1959. December 25, 1958.

Выписка из протокола заседания Учёного совета АН СССР о поддержке кандидатов (Н. Г. Басова и А. М. Прохорова) на Ленинскую премию.

Protocol of the meeting of the USSR Academy of Sciences scientific council on the support of the candidates (N. G. Basov and A. M. Prokhorov) for the Lenin Prize.

In 1959, N. G. Basov and A. M. Prokhorov were awarded the Lenin prize for the discovery of a new principle of generation and amplification of electromagnetic radiation based on quantum systems.

В Комитете по Ленинским премиям в области науки и техники при Совете Министров СССР

О присуждении Ленинских премий за наиболее выдающиеся работы в области науки и техники

«BRINGING TO AN END»

I was lucky to observe one of the manifestations of N. G. Basov's many-sided talent as a scientist, i. e. his phenomenal intuition, which allowed him to quickly get into any new problem and find a way to solve it. And not only show this way to others, but go through it until the final result. I had a chance to see one of the basic principles of Nikolai Gennadievich's work: any work must be brought to an end without any delay, if there is even the slightest possibility. And if necessary, take action yourself.

Once Basov came late in the evening, when I tinkered with the equipment with rather little success. He friendly, as always, greeted me and asked his favourite question: – Well, how is it going on with the science? I had to tell that the science makes no progress. – Never mind! We will urge it on! And Basov took off his coat and sat down beside me at the laboratory table. It did not take long time for me to brief him on the subject: he understood everything in no time and began tuning. And what happened some time after seemed a miracle to me: the power of harmonics began to grow. Basov proposed and implemented new and new tuning versions, which almost always led to success. Two hours later, when the power almost reached the desired level, I said joyfully: – We can stop now: everything is all right. Tomorrow I will get the value we need. But Basov objected: – No, it cannot be postponed. We must bring it to the end right now, while the system operates and obeys us. If we interrupt, the «relaxation processes» will reduce all we achieved to the initial zero for a night. The success must be developed and consolidated! We continued tuning and, as if obeying Basov's will, the power reached the required level. – Well, now we have got a stable regime, and there will be no «night relaxation» – said Basov and immediately took care of me: – Oh! It is half past eleven p. m.! I live nearby, but you have to take a long journey by underground. Let us stop at it and go home. By the way, have you got a free soldering iron? My father-in-law asked me to repair his TV set, but my soldering iron was broken. I delivered my soldering iron to him and gave cautious advice: – Maybe, you would call for a TV service man? – I could surely, but it is not proper to refuse. This was a manifestation of another remarkable property of Basov's character: his readiness to help. Many years after, when thinking of this episode, I could not remember any case where Basov would refuse my personal request. If he could not do what he was asked for particular reasons, he always found ways to help involving other people. In that evening I had a privilege to observe for the first time one of the features of many-sided talent of scientist Basov: his phenomenal intuition, due to which he could rapidly go into the heart of any new problem (theoretical or experimental); find a way to solve it; and, even more, not only indicate this solution to other researchers but, when necessary, implement it to the final result. At the same time, Basov demonstrated one of the main principles of his work: to accomplish any matter if there is any, even very low, possibility and, when necessary, act on one's own.

I remembered these Basov's features later, when heard the story by V. S. Zuev about the launch of the first molecular oscillator. Zuev said: – Basov launched it with his own hands. Only one radio-technician – Vasilii Vasil'evich Nikitin – helped him. *(A. Z. Grasyuk)*

А. З. Грасюк (слева) и В. А. Катулин (в будущем первый директор филиала ФИАН в Самаре), 1964 г.

A. Z. Grasyuk (left) and V. A. Katulin (the first director of Samara branch of FIAN in future), 1964.

Министерство Связи СССР

ТЕЛЕГРАММА

ВОРОНЕЖ 4 ВАСОВУ НИКОЛАЮ ГЕННАДИЕВИЧУ

ВОСКОВ 10/100 17 22 1143

ПОЗДРАВЛЯЮ ВАС С ПОЛУЧЕНИЕМ ЛЕНИНСКОЙ ПРЕМИИ ЗА ОТКРЫТИЕ ЯВЛЕНИЯ УДАЛЕНИЯ ЭЛЕКТРОНОВ

Академику Академии наук СССР

Басову Николаю Геннадиевичу

Глубокоуважаемый

Николай Геннадиевич!

Президиум Академии наук СССР поздравляет Вас с присуждением Вам Ленинской премии за разработку нового принципа генерации и усиления излучения.

Президиум желает Вам здоровья и новых творческих успехов.

(Г.И.Марчук)

(Е.П.Велихов)

22 апреля 1959 г.

ЛАУРЕАТУ ЛЕНИНСКОЙ ПРЕМИИ

ДОКТОРУ ФИЗИКО-МАТЕМАТИЧЕСКИХ НАУК

товарищу БАСОВУ Н.Г.

Уважаемый Николай Геннадиевич!

Сердечно поздравляю Вас с присуждением Вам Ленинской премии за создание молекулярных генераторов и усилителей.

От всей души желаю Вам доброго здоровья и дальнейших творческих успехов в Вашей плодотворной научной работе на благо нашей любимой Родины.

Крепко жму Вашу руку.

А.ГРЕЧКО

Зам.Мин.обороны СССР

22 апреля 1959г.

После присуждения Ленинской премии в адрес Н. Г. Басова поступили многочисленные поздравления.

After the Lenin Prize awarding, Basov received numerous congratulations.

ON THE WAY TO THE OPTICAL REGION

We were not very much surprised by the appearance of Bloembergen and Scovil's works (1956 and 1957) on the amplification in paramagnetic crystals.

<…> But the fact was that the focus of attention had been shifted to the optical region. For me personally, of great importance was the first International Conference on Quantum Electronics and Resonance Phenomena held in New York, in September 14–16, 1959. There I have met Townes, Schawlow, Javan, Scovil, Lamb, Van Fleck, B. Lax and many other outstanding physicists of today. There were about one hundred conference participants present, they represented various scientific associations, which had made a great contribution into the development of postwar physics.

<…> With the development of a molecular oscillator there had been a desire to use the same effect in other wave ranges, in optics for example. We began to discuss that problem with Yu. M. Popov who had worked at that time at the laboratory of luminescence in FIAN. We had known each other very well since our student years at MIFI. The work on optical oscillators had brought us to the understanding of semiconductor laser problems. We proposed to realize a band-band and band-impurity breakdown by short current pulses followed by thermalization of the current carriers, by filling of the levels and the degeneration of the conduction band. For those proposals we received the author's certificate of 1958 (N. Basov, B. Vul, Yu. Popov). The conditions of inverse population in semiconductors were the subject of our first paper which I had reported at the first Conference on Quantum Electronics in Bloomingburg. And there I've heard the reports of Ch. Townes and A. Schawlow, in which they suggested the possibility of a ruby laser, and A. Javan's proposal for a gas-discharged laser. Our own work was not on the conference program, and as far as I remember, my report on semiconductor lasers had been heard over the luncheon. But, nevertheless, it had been welcomed by the conference participants, here I may quote Profs. B. Lax and Ch. Townes, with whom I discussed the idea of semiconductor lasers. We had long discussions of that problem with B. Lax. He thought that the large line width was an obstacle to semiconductor; the quality of the line, so to say, was measured only in unite, and that the generation should be sought not in such broad lines, out in narrower ones. B. Lax considered impurity levels (the Landau levels) more suitable for that, but we wanted to use mostly band-band transitions. Soon our next publication appeared together with O. N. Krokhin and Yu. M. Popov, where we had proposed three more types of the excitation for semiconductor lasers. That was the optical pumping. At one time much attention was paid to that work in press, the excitation of a semiconductor by a ruby laser. Then, the pumping by fast electrons. The third stage of semiconductor laser investigations was the usage of a degenerate p-n junctions, where the direct pumping by the current allowed realization of the state with inverse population. Particular interest was attracted to the problem of electron-beam-pumped semiconductor lasers, it was especially discussed at the second Conference on Quantum Electronics. Today all these methods have been realized. Historically, we began with the breakdown. It seemed to be the simplest technique, though it had been realized only in 1968, the last in turn, since very good current fronts were required for that. At our laboratory the streamer lasers were devised, which allowed the generation on many substances. They had quite a number of interesting applications, like the obtaining of picoseconds pulses, etc. With the experimental realization of p-n junction lasers the American scientists were somewhat ahead of us. To be more exact, the researchers from A.F.Ioffe Physical-Technical Institute were the first to obtain narrowing in the luminescent spectrum of GaAs basing on our works. Then the first publication by Hall with collaborators appeared, then the work by Nathan et al. We had the experimental observation just a few weeks later, but it was not so very important, since lasers of that type were made practically independently. Further investigations performed at A. F. Ioffe Physical-Technical Institute in the group of Zh. I. Alferov) resulted in the construction of semiconductor lasers on heterostructures. At the beginning of 1964 we obtained (together with O. V. Bogdankevich) the laser action in the green spectral region in CdS pumped by fast electrons. In 1964 we obtained the laser action in semiconductors at one- and two-photon excitation by the laser radiation. I. Zubarev is one of the participants of that work. Those works made a significant contribution to the nonlinear optics. They demonstrated both the efficacy of the coherent summation of the radiation from individual lasers, and the possibility of the efficient excitation of various media by the laser radiation. At present, many laser systems operate on that principle. Many other types of lasers were made.

We worked by the program of the Academy of Sciences of the USSR. Laser programs were well financed for that time. The budget permitted one to finance five laboratories of FIAN, the optical and semiconductor laboratories among them. In 1959 we organized a regular laser seminar, we have got the report on those works. And the first large review about the opportunities of new types of lasers has been published in 1960 in "Uspekhi Fiz. Nauk" (Sov. Phys. UFN). Here I read the last paragraph from the text of that review: "There are a lot of various proposals concerning the methods for achieving negative temperature various quantum systems, and some theoretical problems. Most of them have been reported in this review. But not a single paper has been published so far on the possibility of amplification and oscillation regimes in the infrared and optical waveranges. But as seen from this review, there are no principal restrictions to their realization, and thus one can hope that in near future oscillators and amplifiers operating in IR and optical regions would appear". The review was sent to the journal just a few months before T. Maiman's communication in press about the realization of a ruby laser in July, 1960. *(N. G. Basov)*

На Первой международной конференции по квантовой электронике. Слева направо: Г. Цайгер, Н. Г. Басов, Дж. Гордон, А. М. Прохоров, Ч. Таунс. США, 1959 г.

At the first International Conference on Quantum Electronics. Left to right: G. Zeiger, N. G. Basov, J. Gordon, A. M. Prokhorov, Ch. Townes. USA, 1959.

FUNDAMENTAL IDEA

In the work of N. G. Basov with colleagues of 1958 and in a report at the International Conference on Quantum Electronics (USA, 1959), it was proposed to create population inversion in semiconductors by avalanche multiplication of current carriers in a pulsed electric field. This proposal, along with the proposals of US scientists on the use of ruby crystals (C. Townes, A. Schawlow) and gas mixtures (A. Javan, W. Bennett), marked the beginning of the development of quantum electronics in the optical frequency range.

FROM MASER TO LASER

By 1958 it had become clear that the same principles could be extended to the visible range, i. e., to create a generator of electromagnetic radiation in the short, including visible, range. This, of course, was a huge qualitative leap, not only scientific but also psychological, in quantum electronics because it made it possible to understand what the radiation of a quantum generator represented. What interested N. G. Basov as a scientist during those years? Of course, the problems of radiation coherence. That is, how can an ensemble of excited molecules emit highly monochromatic radiation despite the finite lifetime of the excited state? The answer to this question came later: it is important to maintain an excited state from the outside (this process is called «pumping»), and the molecular oscillator (maser) will emit a highly monochromatic wave. In lasers due to the small radiation wavelength another type of coherence – spatial coherence – appears, i. e., the identity of

Н. Г. Басов и Али Джаван, создатель первого газового лазера, в США на первой международной конференции по квантовой электронике. Надпись на фото «На память о нашей старой дружбе. Али.» сделана позже.

N. G. Basov and Ali Javan- the inventor of a gas laser, in the USA at the First International Conference on Quantum Electronics. Inscription on the photo: «To the memory of our old friendship» is made later.

А. М. Прохоров, Н. Г. Басов, А. И. Барчуков. США. 1958 г.
A. M. Prokhorov, N. G. Basov, A. I. Barchukov. USA, 1958.

the oscillations of the electromagnetic field at different points in space. This feature allows one to focus well laser radiation, which is important for many practical applications. N. G. Basov perfectly felt and understood the problems. Generally, if we speak about N. G. Basov as a scientist, then, perhaps, the main feature of his character was inquisitiveness and creative approach. His mind constantly formulated questions and riddles, the answers to which generated new ideas and opened new avenues of research and implementation of new tasks. Thus were born the ideas of frequency and time standards; the ideas of application of semiconductors, realised in highly efficient diode lasers; the ideas of using lasers to heat plasma to high temperatures – so-called laser fusion; the ideas of developing chemical, photodissociation high-power lasers pumped by the light from a shock wave caused by detonation of high explosives; the idea of electroionisation CO_2 lasers, excimer lasers; and so on and so forth. *(O. N. Krokhin)*

LASERS! MORE LASERS!
FUTURE IS ON THEIR SIDE

In July 1960 ... during our meeting Basov told about these and other proposed space experiments and their possible results and made the corresponding calculations and estimates. I had a privilege to participate in them within my powers. The meeting continued for about an hour and a half and impressed me greatly. The cascade of creative ideas put forth by Basov and his exceptional scientific intuition were stunning. At parting Basov said prophetic words: – Obviously, everything we discussed here is very interesting, useful, and urgent. However, the main demand of time is: lasers! More lasers! Future is on their side. *(A. Z. Grasyuk)*

MY OBSESSION WAS THE GREATEST POSSIBLE GAIN

When it came to lasers, my obsession was the greatest possible gain, because it gave a possibility to reduce the volume of the cavity, i. e., to approach the single-mode regime. Large absorption and basically high gain were offered by semiconductors. The abundance of different media having the most diverse concentrations of active particles, lifetimes, different transition frequencies, made it possible to choose the necessary materials. The first substance with which we began to experiment was InSb. Excitation was achieved by a short voltage pulse. *(N. G. Basov)*

Слева направо: А. П. Шотов, Ю. М. Попов, О. Н. Крохин – лауреаты Ленинской премии 1964 г.

Left to right: A. P. Shotov, Yu. M. Popov, O. N. Krokhin, the Lenin Prize Winners 1964.

OPTICAL QUANTUM ELECTRONICS

In 1959, N. G. Basov, together with B. M. Vul and Yu. M. Popov, published the work «Quantum mechanical semiconductor generators and amplifiers of electromagnetic oscillations». To make a laser, it was proposed there to use the inverse population in semiconductors produced in a pulsed electric field. This proposal marked the beginning of the development of quantum electronics in the frequency optical range

SEMICONDUCTOR LASERS

It was with advent of semiconductor lasers that N. G. Basov began to study sources of coherent radiation in the optical region. The paper published in 1961 together with O. N. Krokhin and Yu. M. Popov entitled «Receiving of states with negative temperature in p-n-junction degenerate semiconductors» laid the foundation for the research and development of the so-called injection lasers, which, perhaps, found the widest application at the present time. This work actually anticipated the main ways for the development of this type of lasers.

In that work, a waveguide nature of the active region in such a laser was indicated, and a decrease in threshold current density of a junction laser was predicted when the semiconductors forming a p-n junction would have different forbidden bandwidths (heterojunctions). In 1961, Nikolai Gennadievich Basov proposed, and in 1963, together with his colleagues (O. N. Bogdankevich and others) demonstrated a laser based on the excitation of a semiconductor by an electron beam.

This laser is currently used to make a TV tube in a laser Projection television. Such a TV-set allows projection of an image onto a large cinema screen. In 1964, a group of researchers (A. Z. Grasyuk, I. G. Zubarev, V. A. Katulin) under the leadership of N. G. Basov received, for the first time, the effect of generation due to interband recombination of current carriers in semiconductors at their single-quantum and two-quantum excitation by means of another laser. The research demonstrated the possibility of an effective coherent summation of radiation from individual lasers, and a conversion of the pump laser radiation into a shorter wavelength radiation. *(A. N. Oraevsky)*

Представленные на премию Ленинского комсомола 1979 года младшие научные сотрудники Александр Богатов (слева) и Камиль Хайретдинов. 3 октября 1979 г.

Nominated to the Lenin Komsomol Prize 1979, junior researchers Alexander Bogatov (left) and Kamil Khairetdinov, October 3, 1979.

Приём телевизионного изображения с помощью проекционного лазерного телевизора.

TV image receiving with projected laser TV.

The inventors of the laser TV (N. G. Basov, O. V Bogdankevich and A. S. Nasibov) believe that it is possible to develop a fundamentally new television and cinema system based on lasers of this type. The laser kinescope can also be used in computer and control systems.

Слева направо: И. П. Папуша, А. С. Насибов, В. И. Козловский.

Left to right: V. P. Papusha, A. S. Nasibov and V. I. Kozlovsky.

ФИЗИЧЕСКИЙ ИНСТИТУТ им.П.Н.ЛЕБЕДЕВА АКАДЕМИИ НАУК СССР

УТВЕРЖДАЮ.
Директор
Физического института АН СССР
академик (Д.В.Скобельцын)
«30» декабря 1961г.

ОТЧЁТ
по теме "ПРИМЕНЕНИЕ КВАНТОВЫХ СИСТЕМ ДЛЯ ГЕНЕРАЦИИ, УСИЛЕНИЯ И ИНДИКАЦИИ ОПТИЧЕСКОГО ИЗЛУЧЕНИЯ".

Руководитель работы
доктор физ.-мат.наук -
(Н.Г.Басов)

Ответственные исполнители:
Профессор О.А.Щеглов
Член-корр.АН СССР Б.М.Вул
Профессор В.В.Лебедев
Доктор техническ.наук А.Н.Фридман
Доктор физ.-мат.наук И.Д.Рыжанов
Мл.научн.сотр. Е.Н.Земляницын
Мл.научн.сотр. О.Н.Крохин
Кандидат ф.-м.н. А.Н.Лесников
Кандидат ф.-м.н. В.Н.Малинин
Кандидат ф.-м.н. Е.А.Сошков
Кандидат ф.-м.н. Ю.М.Попов
Кандидат ф.-м.н. С.Г.Раутиан
Кандидат ф.-м.н. Н.Н.Собольник
Кандидат ф.-м.н. З.Ф.Тучкевич

Москва, 1961 г.

Титульный лист отчёта по теме «Применение квантовых систем для генерации, усиления и индикации оптического излучения».

Title page of the report «Application of quantum systems for the generation, amplification and indication of optical radiation».

КВАНТОВОМЕХАНИЧЕСКИЕ ПОЛУПРОВОДНИКОВЫЕ ГЕНЕРАТОРЫ И УСИЛИТЕЛИ ЭЛЕКТРОМАГНИТНЫХ КОЛЕБАНИЙ*

Б.М.Вул, Н. Г. Басов и Ю. М. Попов

ЖЭТФ. 1959. Т. 37. вып. 1(7). С. 587—588.

Совместная работа Н. Г. Басова, Б. М. Вула и Ю. М. Попова «Квантовомеханические полупроводниковые генераторы и усилители электромагнитных колебаний».

The joint paper of N. G. Basov, B. M. Vul, and Yu. M. Popov entitled «Quantum-mechanical semiconductor generators and amplifiers of electromagnetic oscillations».

КОГЕРЕНТНОСТЬ И НАПРАВЛЕННОСТЬ ИЗЛУЧЕНИЯ ОПТИЧЕСКОГО ГЕНЕРАТОРА НА РУБИНЕ

М. Д. Галанин, А. М. Леонтович, З. А. Чижикова

Направленность излучения оптического генератора на кристалле рубина обычно хуже дифракционного предела, определяемого размерами кристалла. Это обусловлено оптическим несовершенством кристаллов. Недьсомом и Коллинсом [1] было показано, что излучение когерентно на протяжении малых областей торцевой поверхности кристалла. Предполагалось, что дифракция на границах этих областей и обусловливает угловое расхождение генерируемого пучка излучения. Однако, как было показано Мастерсом и Перрентом [2], излучение когерентно на участках, отстоящих друг от друга более чем на 3 мм.

Описываемые ниже опыты имели целью исследовать соотношение между когерентностью и направленностью излучения рубинового генератора. Прежде всего было показано, что пульсации излучения при генерации возникают одновременно по всей излучающей поверхности кристалла.

Письма в редакцию

k-е кольцо соответствует условию $2nl\cos\theta_k = (n-k)\lambda$, где l — длина кристалла, n — показатель преломления, θ_k — угол между нормалью к фронту волны внутри кристалла и нормалью к плоскости торца. Измерение диаметров подтверждает это соотношение.

Авторы выражают благодарность А. С. Бебчуку и Ю. Н. Соловьевой за предоставление исследованных кристаллов, а также Б. Н. Лукашину и Н. Е. Шикалину за обработку кристаллов.

Авторы благодарны также Н. Г. Басову за постоянное внимание и обсуждение этой работы.

Поступила в редакцию
18 мая 1962 г.

Литература

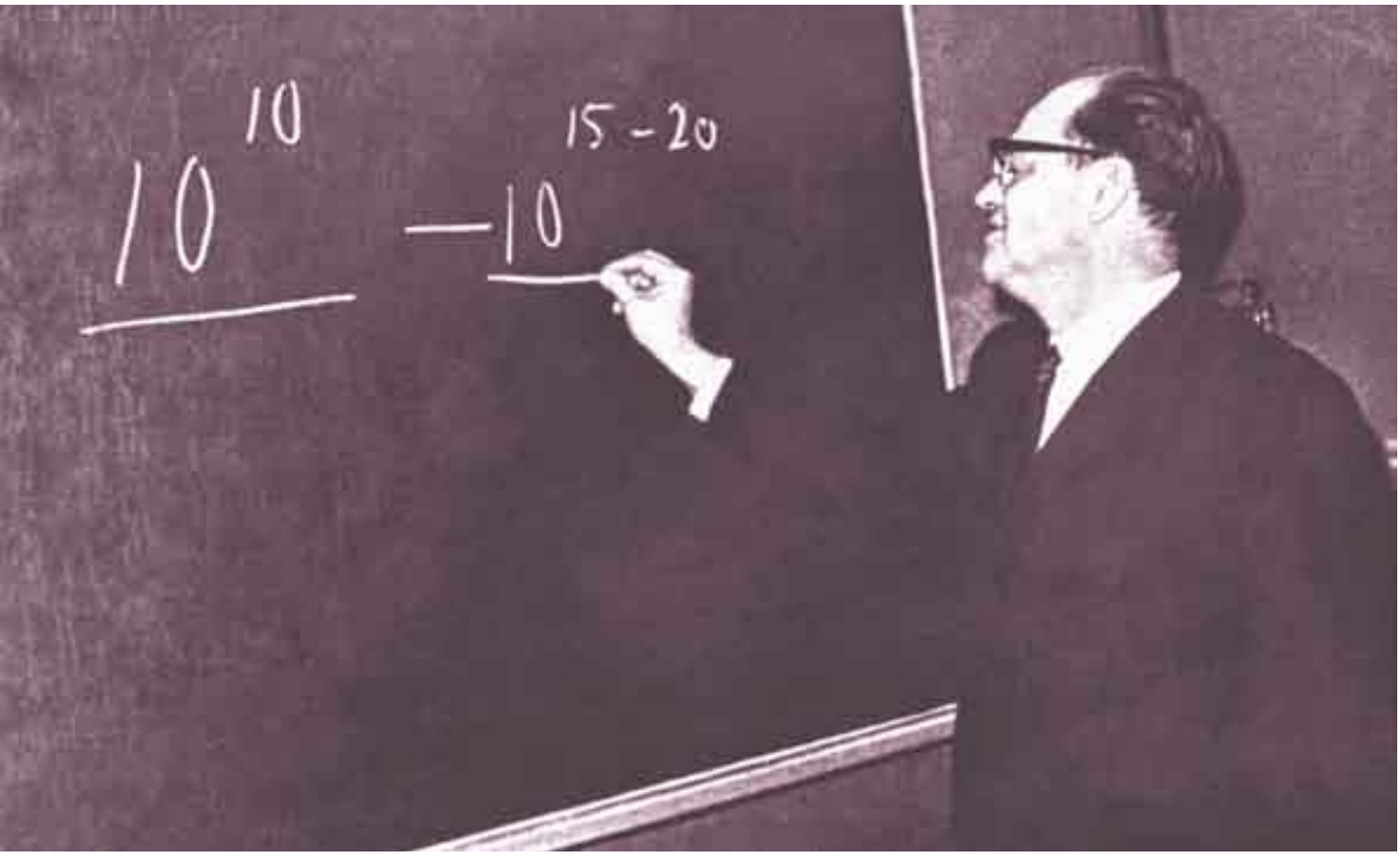
[1] D. J. Nelson, R. J. Collins, J. Appl. Phys., 32, 709, 1961.
[2] J. I. Masters, G. B. Perrent, Proc. of I. R. E., 50, 230, 1962.

Первая публикация в СССР по эксперименту с оптическим лазером (первая и последняя страницы статьи в ЖЭТФ, т. 43, № 7, 1962 г.).

The first publication in the USSR on the experiment with an optical laser (the first and the last pages of the paper published in ZhETF, vol. 43, N 7, 1962).

Н. Г. Басов и М. А. Манько работают над научной статьёй.

N. G. Basov and M. A. Man'ko are working over a manuscript.



Н. Г. Басов в 1960-х годах предсказал возможный прогресс в стандартах частоты при переходе от СВЧ-диапазона к оптике. В настоящий момент (2022 г.) достигнутые результаты по стабильности частоты подтвердили прогноз Н. Г. Басова, сделанный более полувека тому назад.

In the late 60s, N. G. Basov predicted possible progress in the frequency standards under transition from microwave to the optical region. At the moment (2022), results achieved in terms of frequency stability have confirmed the forecast of N. G. Basov made more than half a century ago.

THE GIFT OF PREDICTION

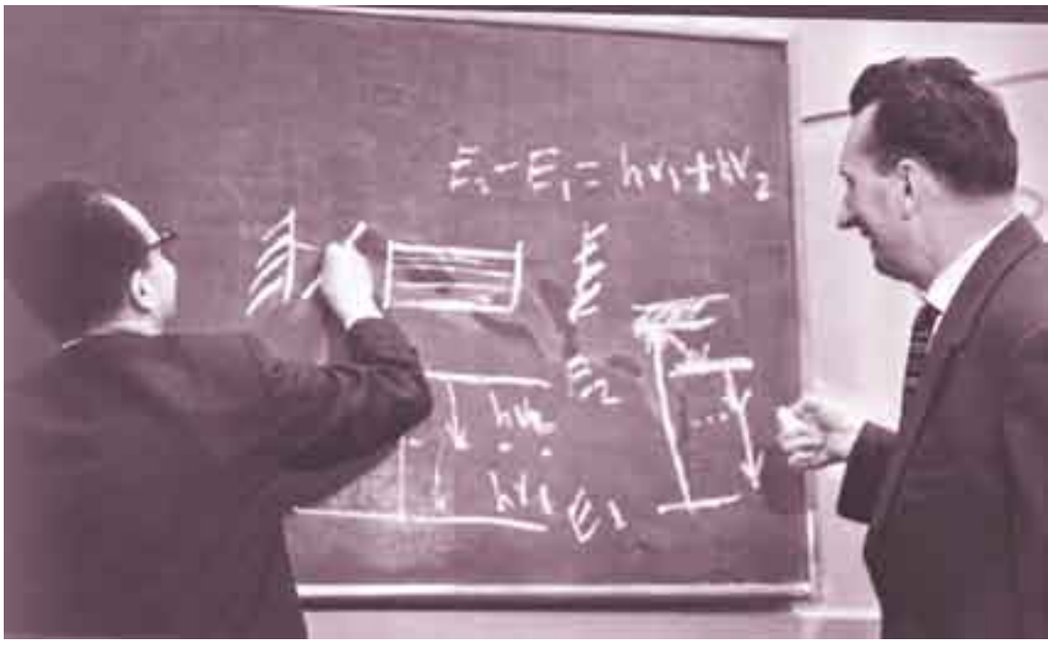
In 1961, that is, immediately after the creation of a laser, Nikolai Gennadievich was invited to make a presentation on lasers and laser prospects at the meeting of the Academy of Sciences Presidium. In his report, he said that the information capacity of the communication channel in the optical range i. e. basing on the laser radiation, should soon be so gigantic that it will be sufficient to cover the whole world with such an information network. And all six billion of people living on Earth will be able to communicate with each other by phone or in some other way. And that was said 50 years ago! To be honest, we did not believe at that time how such a dream could come true – to transmit signals, that is, information, by a laser beam. Well, we tried to guess, say in space, people might see each other and transmit signals. But how to do it on Earth? It was fantastic! However, the prediction came true. Indeed, later on it became possible to produce thin glass fibers with a size of approximately one hundred microns in diameter, including a shell, which practically does not absorb the laser radiation, that is, the signal could be transmitted over long distances. Today we call it «fiber-optic communication lines.» This is television, this is the Internet: please, any library, printed or video production, any work of art you may transfer to another part of the Planet. I think that even this achievement alone – the creation of the World Wide Web Internet – is already enough to appreciate the significance of the laser for humanity. *(Yu. M. Popov)*

FIRST REGULAR SEMINAR

While working on molecular oscillator, N. G. Basov got an idea of extending the principles and methods of quantum radiophysics to the optical frequency region. Since 1957, he has been looking for ways of making an optical quantum oscillator, a laser. He invites young people from the Oscillations laboratory and other FIAN labs, organizes the country's first regular seminar on this problem.

«PHOTON»

While working on molecular oscillator N. G. Basov got the idea of extending the principles and methods of radiophysics and quantum electronics to the optical frequency region. By the time work began on an extensive research program «Application of quantum systems for generation, amplification and indication of optical radiation» and its classified part «Photon» in February 1959, there were not yet performed experimental studies proving the feasibility of generation and amplification of radiation in the optical wavelength range. Only a few papers had been published that extended the principles of quantum generation of coherent radiation using quantum systems to the optical wavelength range. Therefore, the initial objective of the research was to identify specific directions for the development of quantum generators, amplifiers and detectors of optical radiation.

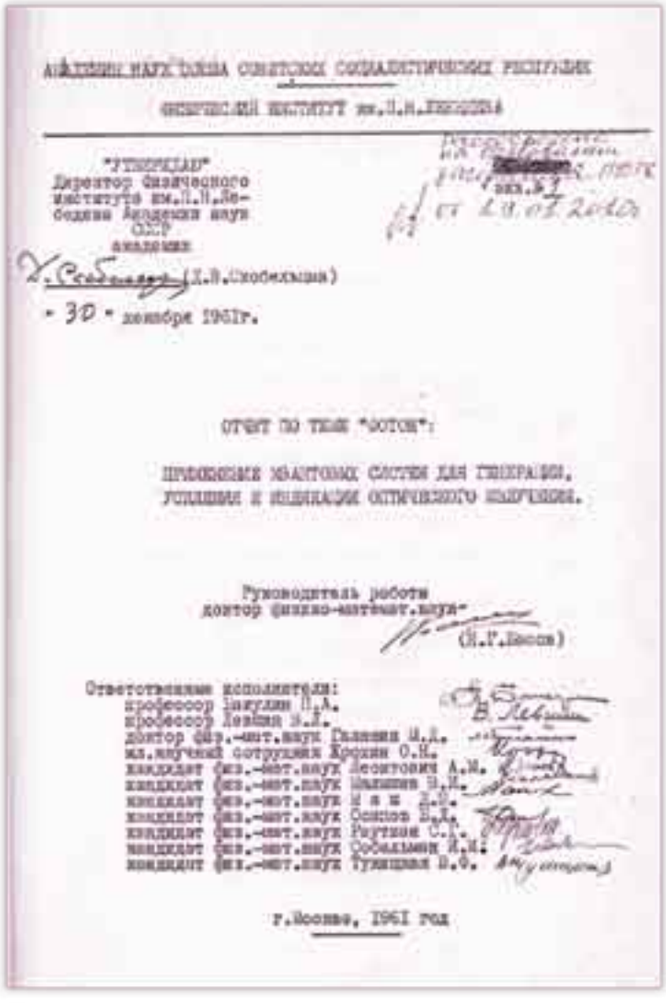


Н. Г. Басов и А. М. Прохоров на семинаре.

N. G. Basov and A. M. Prokhorov at the seminar.

In theoretical and experimental research participated, in addition to the Quantum Radiophysics laboratory (founded in 1963 and headed by N. G. Basov), the laboratories of Oscillations, Optics, Semiconductors, Luminescence, and the Cryogenic Department of FIAN.

The main participants of the program were distinguished FIAN's experts in optical science and semiconductor physics invited by N. G. Basov. As a result of this program, the first Soviet ruby laser was launched by a research team headed by M. D. Galanin and many types of lasers, some of which were pioneering in world practice.



ОТЧЕТ ПО ТЕМЕ "ФОТОН":

Руководитель работы
доктор физико-математ.наук

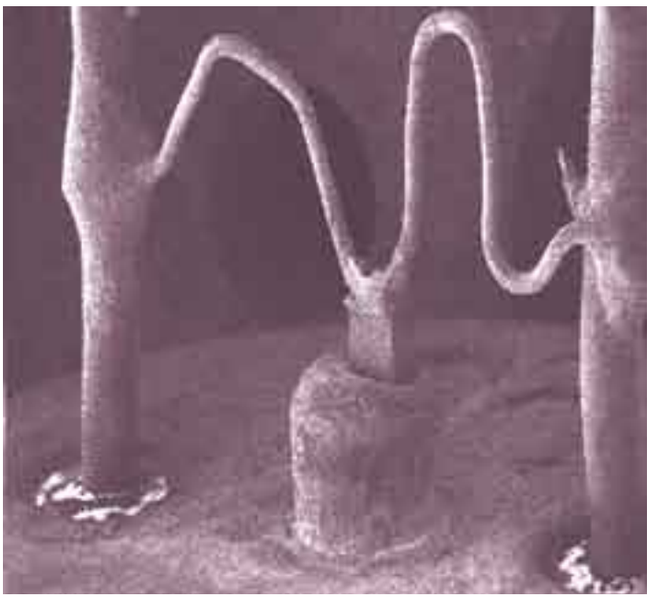
г.Москва, 1961 год

Титульный лист научно-технического отчёта по теме «Фотон». 1961 г.

Title page of the scientific and technical report on the theme «PHOTON», 1961.

LOOKING FOR IDEAS

«I have witnessed more than once how ideas were born in his head. Sometimes it happened as he was sitting at the desk in puffs of tobacco smoke (in his youth he smoked a lot), sometimes he jumped up at night to his desk and wrote down what he dreamed, and sometimes it dawned upon him in the most inappropriate places. I remember: we return one evening from the public baths (the bathrooms were rare at that time), suddenly he stops and says solemnly that finally he reached it, and begins to ardently explain something to me. I believe it was something about a three-level system». *(K. T. Basova)*



Первый инжекционный лазер СССР, созданный в ФИАНе группой под руководством А. П. Шотова (декабрь 1962 г.).

The first injection laser made in the USSR at the Lebedev Physical Institute by a research team headed by A. P. Shotov. December, 1962

Младший научный сотрудник А. С. Семенов изучает оптические логические элементы на основе полупроводниковых лазеров. 1 декабря 1967 г.

Junior researcher A. S. Semenov studying optical logic elements in semiconductor lasers, December 1, 1967.

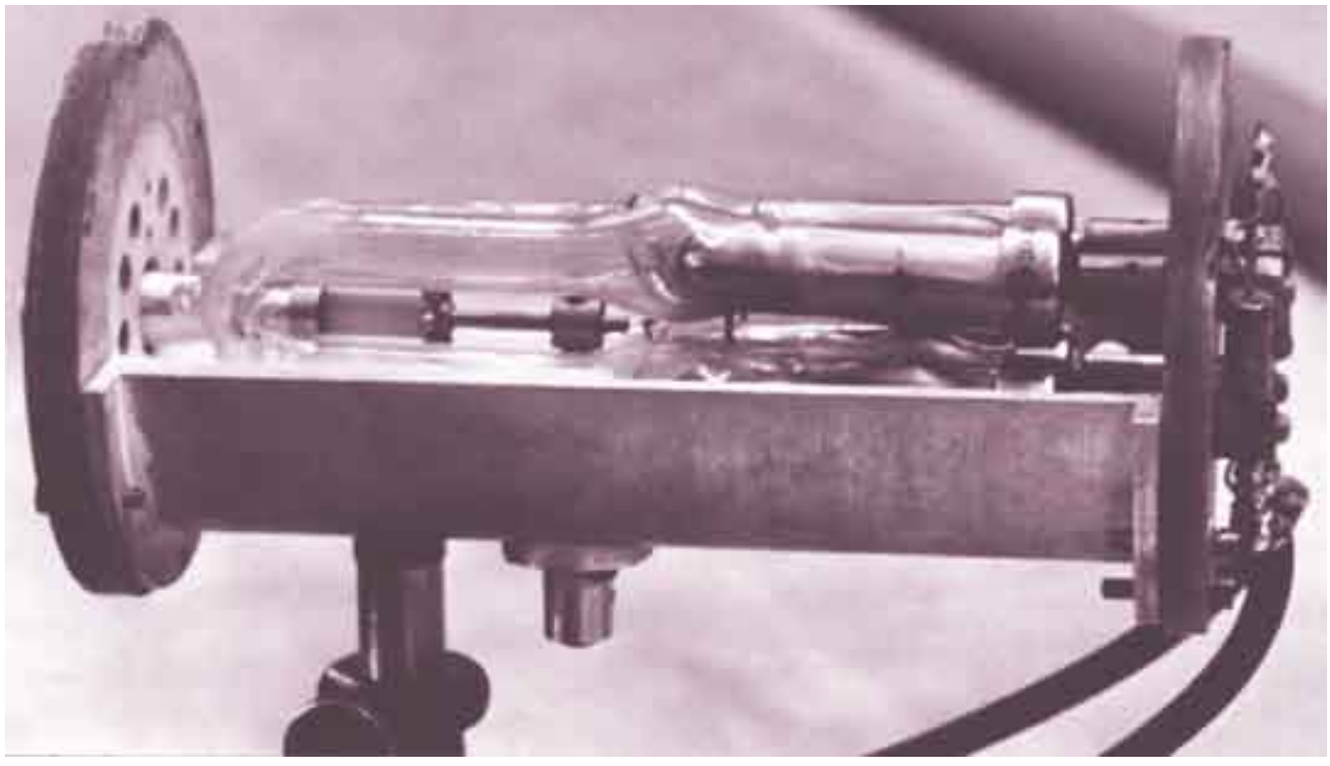
FREQUENCY AND TIME QUANTUM STANDARDS

The first device in quantum electronics was a maser on a molecular beam of ammonia having a frequency stability that was unique at that time. That is why Basov gathered a group of researchers, who were to study the device thoroughly aiming at using it for the frequency and time standards. The group successfully coped with this task.

Subsequently, work on frequency standards under the leadership of Basov was further developed in the optical range. As a result, small-size high-stable laser systems were made that could serve as reliable optical reference points for solving a variety of scientific and applied problems. *(A. N. Oraevsky)*

Кандидат технических наук В. В. Никитин (справа) и аспирант М. А. Губин, юстирующие газовый лазер для исследований стабилизации лазерной частоты. 16 сентября 1974 г.

Candidate of Tech. Sci. V. V. Nikitin (right) and postgraduate student M. A. Gubin adjusting the gas laser used for studying the radiation frequency stabilization, 16.09.1974.



Первый советский рубиновый лазер, созданный в ФИАНе М. Д. Галаниным, А. М. Леонтовичем и З. А. Чижиковой в 1961 г. в процессе работы по теме «Применение квантовых систем для генерации, усиления и индикации оптического излучения».

The first Soviet ruby laser made at the Lebedev Physical Institute by M. D. Galanin, A. M. Leontovich and Z. A. Chizhikova in 1961 during the research on the program «Application of quantum systems for generation, amplification and indication of optical radiation»

ОБЩЕЕ СОБРАНИЕ АКАДЕМИИ НАУК СОЮЗА ССР

ПОСТАНОВЛЕНИЕ

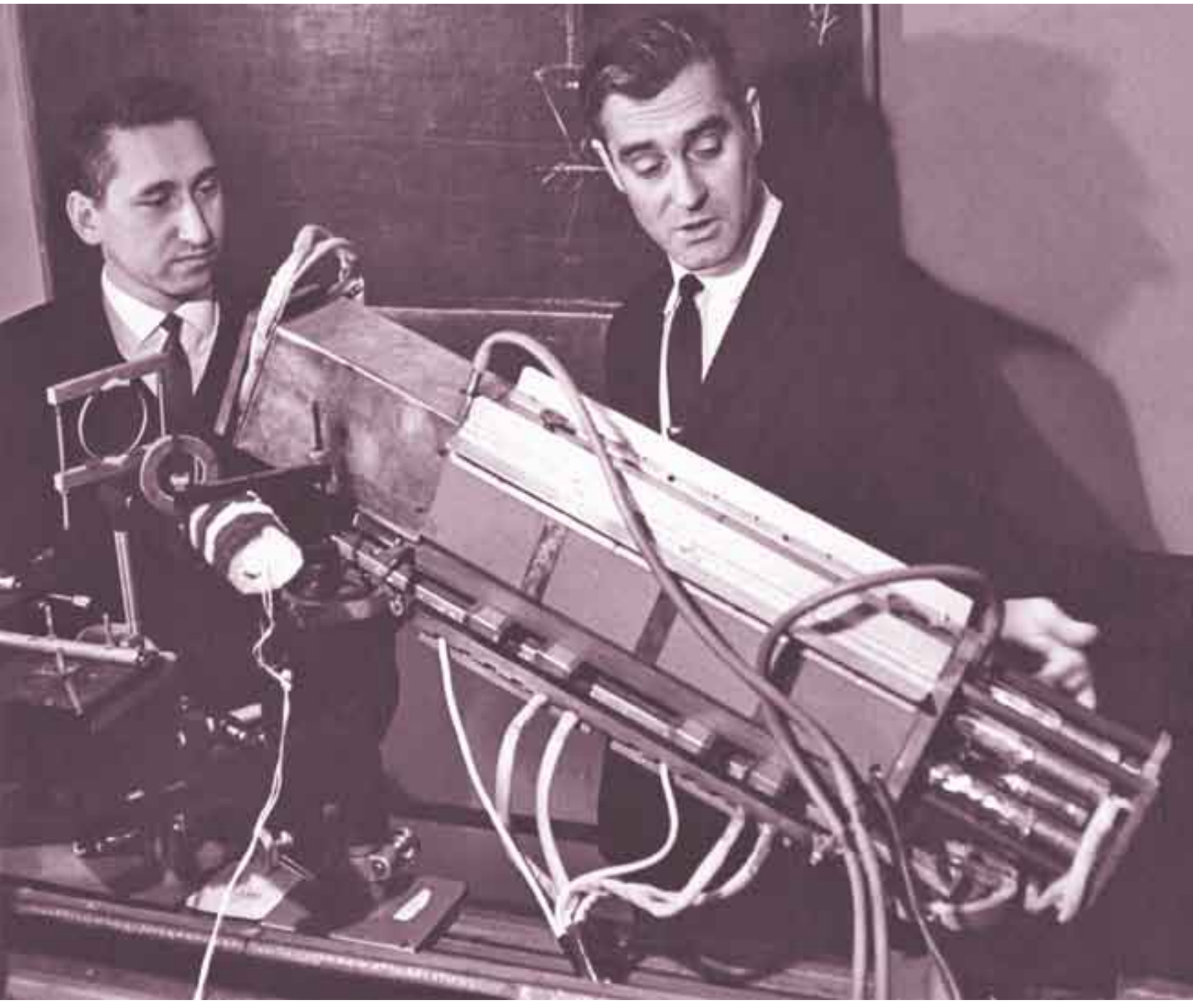
29 июня 62 г.

Постановление Общего собрания АН СССР об избрании Н. Г. Басова членом-корреспондентом АН СССР. 29 июня 1962 г.

Resolution of the USSR Academy of Sciences general meeting on the election of N. G. Basov as a corresponding member. June 29, 1962.

LASER INTERACTION WITH PLASMA

Such laser light properties as a significant energy output within a short period of time and high flux density allowed one to achieve the rate of specific energy input of 10^{18} W/g. This made it possible to heat the matter up to thermonuclear temperatures and compress it to high densities by high pressures due to radiation. We considered this circumstance (together with O. N. Krokhin) in 1962 (report at the Presidium of the USSR Academy of Sciences, March 1962), and in 1963, the first theoretical estimates were reported at the III Conference on Quantum Electronics in Paris.



Лауреаты Ленинской премии д. ф.-м. н. О. Н. Крохин (справа) и к. ф.-м. н. Г. В. Склизков за подготовкой установки для исследования высокотемпературной плазмы с помощью мощного лазера. 1967 г.

Lenin Prize Winners Dr. of Sciences O. N. Krokhin (right) and PhD G. V. Sklizskov over preparing high-power laser facility for studing laser plasma. 1967.

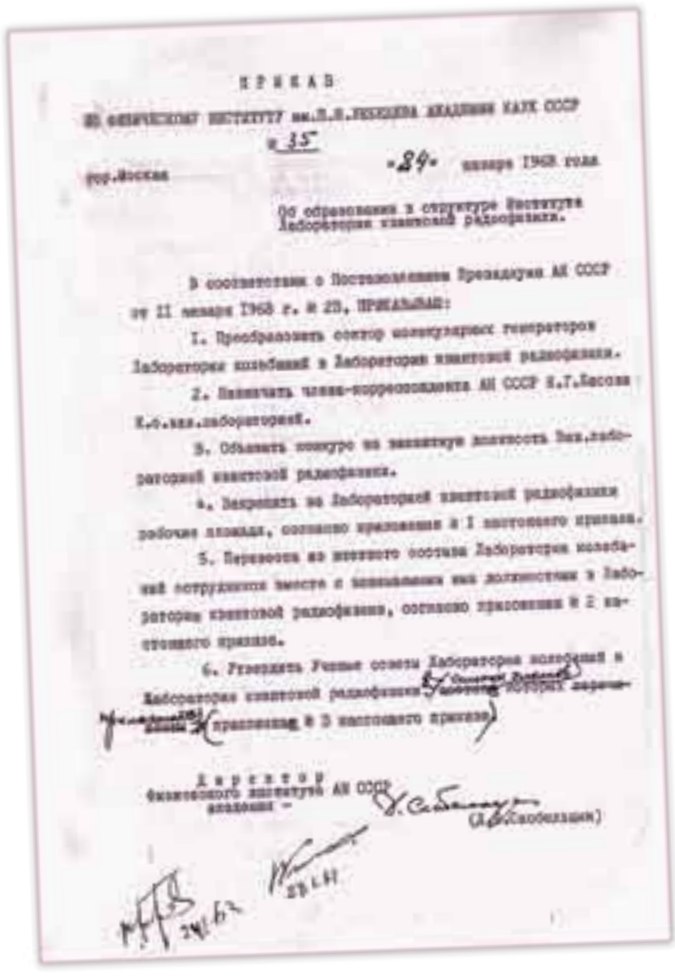
From that time on, theoretical and experimental studies on the interaction of high-power laser radiation with plasma began at the FIAN. Experimental program included the development of ruby and Nd-lasers with record-breaking for that time power parameters.

Already in the fall of 1962, at FIAN, a Q-switching method was proposed for increasing the power of a ruby laser. Experimentally, the method consisted in using a rapidly rotating disc with a hole in the focal plane of two confocal lenses. In the USA, Q-switching was carried out by using a Kerr electro-optical cell. *(N. G. Basov)*

Сотрудники Лаборатории квантовой радиофизики, созданной в 1963 г. Заведующий лабораторией – Н. Г. Басов. Слева направо: 1-й ряд – Ю. Л. Кокурин, В. П. Страхов, А. Н. Успенский, Н. Г. Басов, ?, Т. Борисова; 2-й ряд – ?, А. Н. Печенов, В. Ф. Муликов, ?, Б. М. Лаврушин, Е. В. Козлов, ?, ?, ?, В. Ф. Ефимков; 3-й ряд – В. С. Бушуев, Ю. С. Иванов, А. С. Семёнов, М. И. Вольнов, К. П. Федосеев, В. В. Никитин, В. А. Гончаров; 4-й ряд –?, ?, ?, С. Козлов, А. С. Насибов, О. В. Богданкевич, В. И. Смурыгин, А. Д. Клементов; 5-й ряд – ?, В. Трошагин, ?, ?, ?, П. В. Шапкин, П. Г. Крюков, А. З. Грасюк, С. Д. Захаров, В. Глыва, ?, Л. Д. Михеев. Лето 1967 г.

The staff of the Laboratory of Quantum Radiophysics, established in 1963. Head of the Laboratory – N. G. Basov. From left to right: the 1st row – Yu. L. Kokurin, V. P. Strakhov, A. N. Uspensky, N. G. Basov, ?, T. Borisova; the 2nd row –?, A. N. Pechenov, V. F. Mulikov, ?, B. M. Lavrushin, E. V. Kozlov, ?, ?, ?, V. F. Efimkov; the 3rd row – V. S. Bushuev, Yu. S. Ivanov, A. S. Semenov, M. I. Volnov, K. P. Fedoseev, V. V. Nikitin, V. A. Goncharov; the 4th row –?, ?, ?, S. Kozlov, A. S. Nasibov, O. V. Bogdankevich, V. I. Smurygin, A. D. Clementov; the 5th row –?, V. Troshagin, ?, ?, ?, P. V. Shapkin, P. G. Kryukov, A. Z, Grasyuk, S. D. Zakharov, V. Glyva, ?, L. D. Mikheev.. Summer of 1967.

In addition to many scientific areas, there is the daily painstaking work of N. G. Basov and his team. In our time, when science is developing at an extremely fast pace, a scientist needs not only deep professional knowledge, but also the ability to quickly reorient research to new unexplored problems, without fear of parting with the already accumulated, often very valuable, but aging results. This is the key to scientific success and youth of a scientist. *(O. N. Krokhin)*



ПРИКАЗ

по Физическому институту им.П.Н.Лебедева Академии наук СССР

№ 35

г.Москва «24» января 1963 года

О образовании в структуре Института Лаборатории квантовой радиофизики.

В соответствии с Постановлением Президиума АН СССР от 11 января 1963 г. № 23, ПРИКАЗЫВАЮ:

1. Преобразовать сектор молекулярных генераторов Лаборатории колебаний в Лабораторию квантовой радиофизики.

2. Назначить члена-корреспондента АН СССР Н.Г.Басова и.о.зав.лабораторией.

3. Объявить конкурс на замещение должности зав.лабораторией квантовой радиофизики.

4. Закрепить за Лабораторией квантовой радиофизики рабочие площади, согласно приложения № 1 настоящего приказа.

5. Перевести из штатного состава Лаборатории колебаний сотрудников вместе с занимаемыми ими должностями в Лабораторию квантовой радиофизики, согласно приложения № 2 настоящего приказа.

6. Утвердить Ученые советы Лаборатории колебаний и Лаборатории квантовой радиофизики, которых утвердить согласно приложения № 3 настоящего приказа.

Директор Физического института АН СССР академик — (А.М.Прохоров)

Приложение № 3.

СПИСОК

членов Ученого совета Лаборатории квантовой радиофизики

1. Басов Н.Г.	–	член-корреспондент АН СССР председатель
2. Богданкевич О.В.	–	мл.научный сотрудник
3. Зуев В.С.	–	мл.научный сотрудник
4. Крохин О.Н.	–	мл.научный сотрудник
5. Лисицын Л.М.	–	мл.научный сотрудник
6. Мак Д.Н.	–	ст.научный сотрудник
7. Никитин В.В.	–	инженер
8. Осипов Б.Д.	–	ст.научный сотрудник
9. Ораевский А.Н.	–	ст.научный сотрудник секретарь Ученого совета
10. Попов Ю.М.	–	ст.научный сотрудник
11. Страховский Г.М.	–	ст.научный сотрудник
12. Чихачев Б.И.	–	ст.научный сотрудник

В январе 1963 года Н. Г. Басов с частью сотрудников Лаборатории колебаний выделился в отдельную Лабораторию квантовой радиофизики. Раздел был проведён таким образом, чтобы не была нарушена тематика работы выделившегося коллектива. (Г. А. Прохорова)

In January 1963, N. G. Basov with a part of the Laboratory of Oscillations staff branched off into a separate Laboratory of Quantum Radiophysics. The division was made so that not to break the theme of the work of the singled out team. (G. A. Prokhorova)

PHYSICS OF MOLECULAR OSCILLATORS

Many researches were devoted to high resolution given by molecular oscillators. A number of researches was carried out. In particular, we measured and deciphered the hyperfine structure of the inversion spectrum of deuterized ammonia. V. S. Zuev was the first who started the research and developed a spectroscope, and A. S. Bashkin completed the work.

Together with V. S. Zuev, we were the first to receive radiation at a wavelength of 18 cm on deuterized ammonia, where a quadrupole capacitor was replaced by a ring selector, more convenient in use. We studied very carefully the saturation effect, trying to reproduce it at radio frequencies. We were not surprised by Bloembergen's and Scovil's papers (1956 and 1957) on the amplification in paramagnetic crystals, because our proposals (together with A. M. Prokhorov) on the use of three-level systems with inversion production due to pump radiation dated back to 1955.

We were doing a lot in the physics of molecular oscillator. A. N. Oraevsky worked with me on various theoretical problems of molecular oscillators. They were as follows: frequency stability, coherent radiation, various effects, for example, the Townes traveling wave effect in a resonator, which caused the generation line broadening and decrease in stability.

We thought about how to compensate this effect. An oscillator with two colliding beams was proposed, which for the first time made it possible to experimentally obtain frequency stability of the order of 10^{-12}. This stability was used to develop a frequency standard for the time service. Our oscillators were improved at the All-Union Institute of Physical-Technical and Radio-Engineering Measurements dealing with the time service in the Soviet Union, and they worked there for quite a long time. This is one of the applications of high frequency stability of these oscillators. *(N. G. Basov)*

На заседании Президиума Академии наук СССР.

A meeting of the Presidium of the USSR Academy of Sciences.

Академия наук СССР приглашает Вас
на очередное Общее собрание АН СССР
22 июня 1964 г.
Начало в 11 часов
в Доме ученых АН СССР (ул. Кропоткина, 15).

ПОВЕСТКА ДНЯ:

1. Полупроводниковые квантовые генераторы.
Доклад члена-корреспондента АН СССР
Н. Г. БАСОВА

2. Силовые полупроводниковые преобразователи.
Доклад доктора физико-математических наук
В. М. ТУЧКЕВИЧА

Приглашение на Общее собрание АН СССР 22 июня 1964 года, где в повестке дня значится лекция Н. Г. Басова «Полупроводниковые квантовые генераторы».

Invitation to the general meeting of the USSR Academy of Sciences of 22 June 1964. Basov's lecture «Semiconductor quantum generators» was on the agenda.

ВЫПИСКА ИЗ ПРОТОКОЛА № 8
ЗАСЕДАНИЯ УЧЕНОГО СОВЕТА ФИЗИЧЕСКОГО
ИНСТИТУТА имени П. Н. ЛЕБЕДЕВА
АКАДЕМИИ НАУК СССР

От «17» мая 1964 г.

(Протокол хранится в делах института)

СЛУШАЛИ: О выдвижении члена-корреспондента Академии наук СССР Басова Николая Геннадиевича кандидатом в действительные члены Академии наук СССР по специальности "общая физика".

ПОСТАНОВИЛИ: Выдвинуть члена-корреспондента АН СССР Басова Николая Геннадиевича кандидатом в действительные члены Академии наук СССР по специальности "общая физика."

№ 2/3
18.V.64

Председатель Ученого совета ФИАН академик

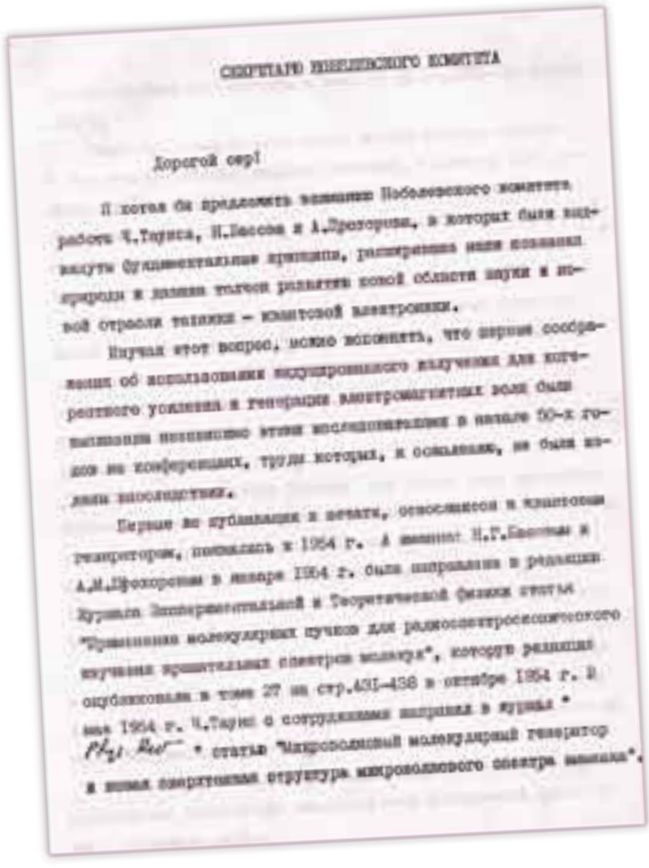
Ученый секретарь ФИАН канд. техн. наук

Выписка из протокола заседания Учёного совета ФИАНа о выдвижении Н. Г. Басова в действительные члены АН СССР. 11 мая 1964 г.

Protocol of the Lebedev Institute scientific council meeting concerning the nomination of N. G. Basov for a full member of the USSR Academy of Sciences. May 11, 1964.

Н. Г. Басов и А. М. Прохоров. 29 октября 1964 г.

N. G. Basov and A. M. Prokhorov. 29 October 1964.



СЕКРЕТАРЮ НОБЕЛЕВСКОГО КОМИТЕТА

Дорогой сэр!

Я хотел бы предложить вниманию Нобелевского комитета работы Ч.Таунса, Н.Басова и А.Прохорова, в которых были выяснены фундаментальные принципы, расширившие наши познания природы и явили толчок развитию новой области науки и новой отрасли техники – квантовой электроники.

Изучая этот вопрос, можно вспомнить, что первые сообщения об использовании индуцированного излучения для когерентного усиления и генерации электромагнитных волн были выполнены независимо этими исследователями в начале 50-х годов на конференциях, труды которых, к сожалению, не были изданы многократно.

Первые из публикаций в печати, относящиеся к квантовым генераторам, появились в 1954 г. А именно: Н.Г.Басовым и А.М.Прохоровым в январе 1954 г. была направлена в редакцию Журнала Экспериментальной и Теоретической физики статья "Применение молекулярных пучков для радиоспектроскопического изучения вращательных спектров молекул", которая реально опубликована в томе 27 на стр.431–438 в октябре 1954 г. В мае 1954 г. Ч.Таунс с сотрудниками направил в журнал "Phys. Rev." статью "Микроволновый молекулярный генератор и новая вращательная структура микроволнового спектра аммиака".

Эти работы были опубликованы в томе 26 на стр.283–284 в мае 1954 г.

Основная ценность этих работ, на мой взгляд, состоит в том, что они явились первыми работами, в которых было открыто свойство когерентности индуцированного излучения возбужденных квантовых систем и указано на возможность получения генерации и усиления посредством введения в квантовую систему обратной связи.

Я хотел бы подчеркнуть, что именно свойство когерентности индуцированного излучения позволило создать новый тип генераторов и усилителей электромагнитных волн. Собственно его открытие положило начало развитию новой области радиофизики – квантовой электроники, которая в настоящее время достигла выдающихся успехов.

В своих последующих работах они также дали дальнейшее развитие целого направления моих принципов, как в области теории, так и в области эксперимента. Здесь, пожалуй, нет необходимости перечислять все эти исследования, поскольку не они являются тем предметом, на котором я хотел бы сконцентрировать Ваше внимание.

Это многообразие работ по квантовым генераторам, которое мы имеем в настоящее время, так или иначе отражает основные идеи, выдвинутые и сформулированные независимо и одно и то же время Ч.Таунсом, Н.Басовым и А.Прохоровым.

Я надеюсь, что мои доводы достаточно основательны для рассмотрения Нобелевским комитетом моих соображений, изложенных в настоящем письме.

Письмо Д. В. Скобельцына в Нобелевский комитет.

A letter of D. V. Skobeltsyn to the Nobel Committee.

NOMINATION FOR THE NOBEL PRIZE

The Nobel Prize is awarded on the proposal of the most prominent scientists in various countries, to whom the members of the Nobel Prize committee send out requests for candidates for this award. Such requests were sent annually to academician D. V. Skobeltsyn, the director of the Lebedev Physical Institute.

Dmitry Vladimirovich considered it necessary to propose his young colleagues, corresponding members N. G. Basov and A. M. Prokhorov, as well as professor of Columbia University C. Townes, as candidates for the Nobel Prize 1964. Simultaneously and independently, these scientists were proposed as candidates for the Nobel Prize by other scientists from the Soviet Union and foreign countries.

Посол Швеции в СССР Г. Ярринг прибыл в ФИАН поздравить новых нобелевских лауреатов. Москва, 29 октября 1964 г. Слева направо: в первом ряду – Г. Ярринг, Н. Г. Басов, А. М. Прохоров, М. Д. Миллионщиков, Д. В. Скобельцын.

G. Yarring, the Ambassador of Sweden in the USSR visited FIAN to congratulate the new Nobel Prize Winners. Moscow, 29 October 1964. Left to right (the first row): G. Yarring, N. G. Basov, A. M. Prokhorov, M. D. Millionshchikov, D. V. Skobeltsyn.

Представитель посольства Швеции в СССР объявляет о присуждении Нобелевской премии Н. Г. Басову и А. М. Прохорову. Среди присутствующих – академик М. Д. Миллионщиков и директор Физического института академик Д. В. Скобельцын. 1964 г.

A representative of the Embassy of Sweden in the USSR announces the awarding of the Nobel Prize to N. G. Basov and A. M. Prokhorov. Among those present are academician M. D. Millionshchikov and Director of P. N. Lebedev Physical Institute academician D. V. Skobeltsyn, 1964.

Пресс-конференция в Президиуме АН СССР нобелевских лауреатов Н. Г. Басова и А. М. Прохорова для журналистов. 4 ноября 1964 г.

Press conference of the Nobel Prize Winners N. G. Basov and A. M. Prokhorov in the Praesidium of the USSR Academy of Sciences, November 4, 1964.

NEWS FROM THE SWEDISH EMBASSY

In the last days of October, the Swedish Ambassador Gunnar Jarring arrived at FIAN, together with the vice-president of the USSR Academy of Sciences Mikhail Dmitrievich Millionshchikov. And in the presence of academician D. V. Skobeltsyn, Gunar Jarring solemnly announced the positive decision of the Nobel Committee and very warmly congratulated the awarded. *(G. A. Prokhorova)*

THANKS TO SKOBELTSYN

It must be emphasized that this Nobel Prize, as well as all works on quantum electronics at FIAN, are very closely associated with the name of D. V. Skobeltsyn. It was he who presented these works to the Nobel Committee. However, the main thing is that he had a unique ability to recognize in the other people's work that essential which was capable of development. Dmitry Vladimirovich timely assessed the prospects for the development of quantum electronics and provided, perhaps, basic support to these works. *(N. G. Basov, N. A. Dobrotin, A. I. Isakov)*

ИНТЕРВЬЮ «ИЗВЕСТИЙ»

СОЗДАТЕЛИ КВАНТОВОЙ ЭЛЕКТРОНИКИ

О присуждении советским физикам Нобелевской премии рассказывает академик М. МИЛЛИОНЩИКОВ, вице-президент Академии наук СССР

Вечером 29 октября в имел честь вместе со шведским послом в Москве г-ном Г. Ярингом поздравить членов-корреспондентов Академии наук СССР Николая Геннадиевича Басова и Александра Михайловича Прохорова с присуждением им Нобелевской премии по физике за 1964 год. Они получили ее вместе с американским физиком Чарльзом Таунсом за фундаментальные работы в области квантовой электроники, которые привели к созданию генераторов и усилителей в радио- и оптическом диапазонах волн (так называемых мазеров и лазеров).

Отличительная особенность квантовых генераторов в том, что их излучение — результат согласованной генерации электромагнитных волн отдельными атомами или молекулами вещества. Давно было известно, что атом — это своего рода миниатюрная радиостанция. Каждый атом способен поглощать и испускать электромагнитные волны, в примеру, видимый свет. Но излучение множества атомов напоминает неупорядоченную работу многих радиостанций, создающих хаос в эфире. Долгое время никому не удавалось заставить атомы давать согласованное, однородное или, как говорит физика, когерентное излучение. Именно это было достигнуто в мазерах и лазерах.

Принцип работы мазеров и лазеров состоит в том, что если достаточно большая доля атомов вещества будет возбуждена (то есть получит избыточную энергию), то среда может усиливать излучение одной определенной длины волны. Н. Г. Басов и А. М. Прохоров предложили метод, в котором для создания такой активной среды используется колебательное излучение — «соседнее». Этот метод сейчас является основой почти всех современных квантовых генераторов и усилителей.

В 1953—1955 гг. Н. Г. Басовым и А. М. Прохоровым была развита теория квантовых генераторов и создан молекулярный генератор на пучке молекул аммиака.

Фундаментальные работы Н. Г. Басова и А. М. Прохорова в области квантовой радиофизики, оригинальность и глубина заложенных ими идей и широкие экспериментальные исследования принесли Н. Г. Басову и А. М. Прохорову международную известность. В 1959 г. за разработку нового принципа генерации и усиления радиоволн, создание молекулярных генераторов и усилителей Н. Г. Басову и А. М. Прохорову была присуждена Ленинская премия.

На счету современной квантовой электроники много блестящих достижений. Долгое время радиоэлектроника билась над созданием генераторов и усилителей с высокой стабильностью и малым уровнем шумов, т. е. высокой чувствительностью. Теперь это стало возможным. Высокочувствительные квантовые усилители — мазеры способны улавливать крайне слабые сигналы тех или иных отдаленных галактик. Очень много в печати писалось о замечательных возможностях лазеров — оптических квантовых генераторов.

Связь с космическими кораблями, ускорение хода химических реакций, сварка ряда металлов, даже лечение ряда заболеваний — вот далеко не полный перечень применений квантовых генераторов и усилителей. Область их использования с каждым днем стремительно расширяется.

Сейчас Н. Г. Басов и А. М. Прохоров руководят лабораториями Физического института Академии наук СССР, в они находятся в расцвете творческих сил и работают над дальнейшим развитием квантовой электроники, в том числе и над практическим ее использованием. В последние годы в ФИАНе под руководством Н. Г. Басова были созданы полупроводниковые квантовые генераторы, обладающие исключительно высокими коэффициентом полезного действия и имеющие большие перспективы практического применения. А. М. Прохоров успешно работает в области применения парамагнитных усилителей в радиоастрономии.

Исследования Н. Г. Басова, А. М. Прохорова и Ч. Таунса развивались во ряде стран параллельно и независимо. Каждый из них внес значительный вклад в большую, новую и важную область физики — квантовую электронику. Присуждение им Нобелевской премии по физике будет приветствоваться всей мировой научной общественностью.

Мы горды, что теперь в славной плеяде советских ученых — лауреатов Нобелевской премии прибавились имена Н. Г. Басова и А. М. Прохорова.

Шереметьевский аэропорт. Перед отлётом в Стокгольм за Нобелевской премией. Н. Г. Басов и А. М. Прохоров дают интервью корреспонденту Н. К. Железнову.

Sheremetievo airport. Interview of N. G. Basov and A. M. Prokhorov to the journalist N. K. Zheleznov before leaving for Stockholm.

THE AWARD IS NOT AN END IN ITSELF

In 1964, A. M. Prokhorov, and Charles Townes, and me became Nobel Prize Winners. Of course, such recognition was a great joy for us, but for a scientist, awards cannot be an end in itself. They will find you if you are passionate about your research, selflessly serve it, and strive to open your new ways in it. Thus, our research in the field of radio-spectroscopy has grown into a new direction in physics. Modern resources of science make it possible to solve the problems facing mankind associated with the development of technology and production. Humanity is comprehending deeper and deeper into the laws of nature and social development, and this process, apparently, has no limit. Knowledge and the ability to apply these laws are our main wealth. We improve and rebuild our life, fill it with new content based on this knowledge. But the acquisition of knowledge is a complex multifaceted process that requires hard work and bold creative thought. Science, like art, does not tolerate dullness, falsehood, and indifference. Goethe said: «A person must believe that the incomprehensible can be understood, otherwise he would not have started thinking about it.» A scientist's philosophical view of what he is doing helps him to comprehend specific problems. *(N. G. Basov)*

Нобелевские лауреаты с супругами прилетели в Стокгольм. 4 декабря 1964 г. Слева направо: К. Т. Басова, Н. Г. Басов, Г. А. Прохорова, А. М. Прохоров.

Nobel laureates with their wives arrived in Stockholm, December 4, 1964. Left to right: K. T. Basova, N. G. Basov, G. A. Prokhorova, A. M. Prokhorov.

AT THE FIRST PRESS-CONFERENCE

The road flashed by quickly, a majestic old building rose in front of them. Grand Hotel! Several respectable gentlemen were already waiting for them in the lobby. They did not have to rest… The first press-conference fell upon them.

From the traditional questions «have you been to Sweden before and how did you like Stockholm», they moved on to questions about scientific plans, new laureates, about how they assess the prospects for the development of quantum electronics. But the reporters were still not satisfied. They were looking for a «zest», and someone turned to Mrs. Basova: does she understand anything in her husband's work? A young dark-haired woman with a high hairstyle looked round those present with lively shining eyes and, smiling slightly, said: – This is not an easy question. The fact is that my husband followed in my footsteps.

The hall froze. Even the cameras went silent. – I'm a physicist. As a student, I studied molecular beams in my Thesis. And so, my husband and professor Prokhorov created a quantum oscillator, in which a molecular beam plays the main role. Everyone laughed and applauded.

– And then? – there were voices.

– Then I started researching semiconductors. And what? My husband suggested the use of semiconductors to make a laser, and soon built various types of semiconductor lasers.

– So, part of the Nobel Prize rightfully belongs to you! – someone from the audience noticed in the tone of her answer.

The reporters were delighted. *(I. Radunskaya)*

Нобелевские лауреаты 1964 года: американский биохимик К. Э. Блох, немецкий биохимик Ф. Линен, Н. Г. Басов, английский химик Д. Кроуфут-Ходчкин, А. М. Прохоров, Ч. Х. Таунс.

Nobel Prize Winners 1964: American biochemist K. E. Bloch, German biochemist F. Lynen, N. G. Basov, British chemist D. Crowfoot-Hodgkin, A. M. Prokhorov, Ch. Townes.

Торжественное заседание Королевской Академии наук Швеции. Церемония вручения Нобелевских премий. Стокгольм, 1964 г. В первом ряду сидят (слева направо): Ч. Х. Таунс, А. М. Прохоров, Н. Г. Басов, английский химик Д. Кроуфут-Ходчкин, американский биохимик К. Э. Блох, немецкий биохимик Ф. Линен.

Grand meeting of the Academy of Sciences of Sweden. The Nobel Prize award ceremony. Stockholm 1964. The first row, left to right: Ch. Townes, A. M. Prokhorov, N. G. Basov, British chemist D. Crowfoot-Hodgkin, American biochemist K. E. Bloch, and German biochemist F. Lynen.

ROYAL RECEPTION

The main celebration took place in the concert hall under the sound of fanfare. King of Sweden Gustav VI Adolf solemnly awarded the laureates with diplomas and medals. Then there was a big reception at the royal palace.

Young princesses were smiling and friendly, older princesses were majestic, their tiaras radiated thousands of lights. Ladies, out of respect for the queen who was then 82 years old, had to be in white, as she preferred that color. The laureates took turns talking by the fireplace with the king, who looked more like a scientist – he was indeed a scientist in the field of paleontology, and the queen, in a short conversation, told us that she visited Russia for the tercentenary of the Romanov dynasty. *(K. T. Basova)*

NOBEL CEREMONY

The ceremony begins. On stage, the students throw up fanfare again. The royal family and everyone in attendance stand up. Slowly Nobel laureates appear. They enter in pairs: each laureate accompanied by a member of the Nobel Committee. They are greeted with applause. Hymns are heard. After the bow laureates sit down, as well as everyone present. The official part is opened by the President of the Nobel Foundation, Professor Tiselius (Nobel Prize Winner in chemistry, 1948). His speech is dedicated to the goals and objectives of the Nobel Prizes. Next, each Nobel laureate is introduced.

They start with physicists, by seniority: Professor Charles H. Townes (USA), Professor Alexander Mikhailovich Prokhorov (USSR), Professor Nikolai Gennadievich Basov (USSR). Each of them gets up

Король Швеции Густав VI Адольф вручает Нобелевскую медаль и диплом американскому учёному Чарльзу Таунсу. Справа готовятся подойти к королю А. М. Прохоров и Н. Г. Басов.

The king of Sweden Gustav VI Adolf hands the Nobel medal and the diploma to the American scientist Charles Townes. On the right: A. M. Prokhorov and N. G. Basov are preparing to approach the king.

and bows. They are presented by the professor of the Swedish Academy of Sciences Bengt Edlen. He commences solemnly: «The prize is awarded for the fundamental work in the field of quantum electronics, which led to the creation of oscillators and amplifiers based on the principle of lasers-masers…». Then follows by a detailed history and content of the works. The speech ends with the words: «The discovery of the laser gave researchers a remarkable new tool, the operational capabilities of which are still in their infancy. Potential laser capabilities are widely known and recognized both in the field of technology and not less in the field of communications. When it comes to the special use of this huge bundle of energy, it is necessary to understand, that such energy, very limited in time and space, is of particular importance when one is working on a microscale, for example, during microsurgical operations. It should be noted that the laser radiation does not cause harm if you take certain care. The myth of the «death ray» can therefore be finally and irrevocably refuted…».

Then a table with awards is being rolled up to the king. Three physicists, in the same order in which they were presented, descend the grand staircase from the stage and approach the king. The king awards each laureate with a diploma and a large gold medal. The awarded bow and rise to their place. At the awards ceremony, everyone present is standing. Even the queen is standing, despite her old age and serious illness. We stand so close that we hear the wishes of the king to each recipient. All reports and conversations are in English. *(G. A. Prokhorova)*

DOUBLE HOLIDAY

The presentation of the prize almost coincided with the birthday of Nikolai Gennadievich – on December 14 he turned forty-two. He turned out to be the youngest of the laureates. Nobel festival with its fireworks and torches, this is, of course, a fairy tale that was invented to brighten up the gloomy December weather in Stockholm. One of the princesses told us so. *(K. T. Basova)*

Король Швеции Густав VI Адольф вручает диплом и медаль нобелевского лауреата Н. Г. Басову. 10 декабря 1964 г.

The king of Sweden Gustav VI Adolf hands the Nobel medal and the diploma to N. G. Basov. December 10, 1964.

Нобелевские лауреаты 1964 года:
Ч. Х. Таунс, А. М. Прохоров, Н. Г. Басов, английский химик Д. Кроуфут-Ходчкин, американский биохимик К. Э. Блох, немецкий биохимик Ф. Линен.

Nobel Prize laureates 1964: Ch. Townes, A. M. Prokhorov, N. G. Basov, British chemist D. Crowfoot-Hodgkin, American biochemist K. E. Bloch, and German biochemist F. Lynen.

Начало нобелевской лекции Н. Г. Басова.
The beginning of N. G. Basov's Nobel Lecture.

SEMICONDUCTOR LASERS

by

NICOLAI G. BASOV

Nobel Lecture, December 11, 1964

In modern physics, and perhaps this was true earlier, there are two different trends. One group of physicists has the aim of investigating new regularities and solving existing contradictions. They believe the result of their work to be a theory; in particular, the creation of the mathematical apparatus of modern physics. As a by-product there appear new principles for constructing devices, physical devices.

The other group, on the contrary, seeks to create physical devices using new physical principles. They try to avoid the inevitable difficulties and contradictions on the way to achieving that purpose. This group considers various hypotheses and theories to be the by-product of their activity.

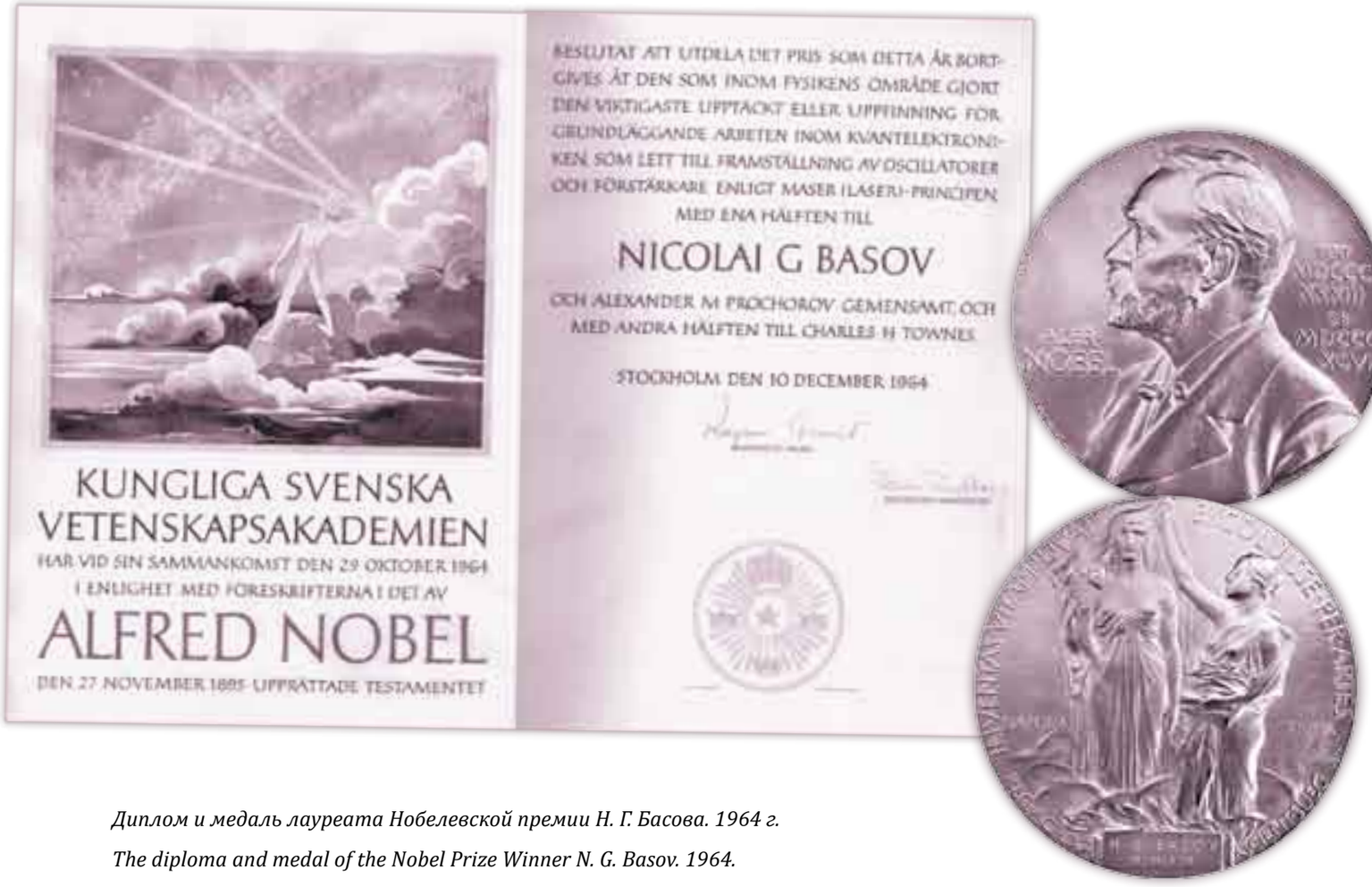
AMONG NOBEL PRIZE WINNERS

Nikolai Gennadievich did a lot in the field to which he devoted his life. I take the liberty of arguing that if there were a Nobel Prize rating, then the Prize «For fundamental research that led to the creation of masers and lasers», obtained by him in 1964 together with A. Prokhorov and C. Towns, would have taken one of the first places.

Indeed, the contribution of quantum electronics to modern civilization is extremely high and comparable to the discoveries of X-rays, radio, transistors. *(O. N. Krokhin)*

Слева направо: Н. Г. Басов, Г. А. Прохорова, К. Т. Басова, А. М. Прохоров. Стокгольм. 1964 г.

From left to right: N. G. Basov, G. A. Prokhorova, K. T. Basova, A. M. Prokhorov. Stockholm. 1964.



Диплом и медаль лауреата Нобелевской премии Н. Г. Басова. 1964 г.

The diploma and medal of the Nobel Prize Winner N. G. Basov. 1964.

Директор банка Э. Валенборг выдаёт денежные премии нобелевским лауреатам Н. Г. Басову и А. М. Прохорову. По 50 тысяч шведских крон.

The director of the bank E. Valenborg gives monetary prizes to the Nobel laureates N. G. Basov and A. Prokhorov (50 thousand Swedish krona each).

ПРАВИТЕЛЬСТВЕННАЯ ТЕЛЕГРАММА

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PROFESSOR NIKOLAI BASOV
LEBEDEV INSTITUTE FOR
PHYSICS LENINSKIY
PROSPECT 53 MOSCOW

RR150 STOCKHOLM 65 29 1705

ROYAL ACADEMY OF SCIENCE TODAY AWARDED YOU AND PROCHOROV
JOINTLY ONE HALF OF THE 1964 NOBEL PRIZE FOR PHYSICS THE
OTHER HALF GOING TO TOWNES ALL FOR FUNDAMENTAL WORK
IN QUANTUM ELECTRONICS LEADING TO PRODUCTION OF
OSCILLATORS AND V AMPLIFIERS ON MASER LASER PRINCIPLE OUR
WARM CONGRATULATIONS LETTER WILL FOLLOW ERIK RUDBERG
THE PERMANENT SECRETARY COL RS=

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NOBEL PRIZE WINNERS IN STOCKHOLM:

STOCKHOLM, SWEDEN: TONIGHT KING GUSTAV OF SWEDEN MADE THE PRESENTATION TO THIS YEAR'S NOBEL PRIZE WINNERS. OUR PICTURE SHOWS THE RECIPIENTS AFTER THEY HAD RECEIVED THEIR AWARDS.

FROM LEFT TO RIGHT THEY ARE, DR CHARLES TOWNES, OF MASSACHUSETTS INSTITUTE OF TECHNOLOGY (MIT), CO-WINNER OF THE PHYSICS AWARD; PROF. ALEKSANDER PROCHOROV (WHO SHARES PHYSICS AWARD) OF LEBEDEV INSTITUTE, MOSCOW; PROF. NIKOLAI BASOV ALSO OF LATTER INSTITUTE, SHARER OF ONE-HALF OF THE PHYSICS AWARD; PROF. DOROTHY CROWFOOT-HODGKIN OF ENGLAND'S OXFORD UNIVERSITY, THE FIRST WOMAN TO RECEIVE A NOBEL PRIZE SINGLY SINCE MADAME MARIE CURIE WON IT FOR HER RADIOLOGICAL RESEARCH IN 1911. PROFESSOR DOROTHY RECEIVED IT FOR CHEMISTRY, AND PROF. KONRAD BLOCH, GERMAN-BORN FACULTY MEMBER OF HARVARD WHO SHARED THE MEDICINE AWARD WITH PROF. FEODOR LYNEN OF THE MAX PLANCK INSTITUTE, MUNICH.

10TH DECEMBER, 1964-PN-ON

UNITED PRESS INTERNATIONAL PHOTO

Нобелевские лауреаты по физике 1964 года:
Николай Геннадиевич Басов
и Александр Михайлович Прохоров.

Nobel Prize Winners in physics 1964:
Nikolai Gennadievich Basov and Alexander
Mikhailovich Prokhorov.

Академики, лауреаты Нобелевской премии.
Слева направо: Н. Г. Басов, Н. Н. Семёнов, А. М. Прохоров.

The Nobel Prize Winners. Left to right: N. G. Basov,
N. N. Semenov and A. M. Prokhorov.

The letter of congratulations from the Nobel Prize Winner in Chemistry N. N. Semenov, 31 Oct 1964.

Дорогой Николай Геннадиевич,

Горячо поздравляю Вас с мировым признанием Вашего исторического вклада в физику.

Очень рад и за Вас лично и за нашу Советскую науку. Нобелевские премии по естествознанию помимо авторитетного признания масштаба открытия, устанавливают приоритет данных дел. Эта последняя сторона дела подвергается тем самому тщательному анализу и тут они, как правило, не допускают никаких ошибок. Эта сторона дела, как я думаю, имеет для Вас и для нашей науки, также немаловажное значение, т.к., увы, встречаются у нас и такие ученые, которые охотнее признают приоритет иностранцев, чем своих советских ученых.

Вы получили свою Советской науки. Желаю Вам дальнейших столь же крупных творческих успехов, желаю Вам подарить нашей Родине технические плоды Вашего открытия в таком масштабе и степени оригинальности, которые далеко оставили бы позади соответствующие достижения США и других капиталистических стран.

С приветом

Н.Семенов

31/X 64 г.

Н. Г. Басов и нобелевский лауреат по химии академик
Н. Н. Семёнов (в центре).

N. G. Basov and Nobel Prize Winner
in chemistry Academician N. N. Semenov (in the center).

На празднике в ФИАНе в честь лауреатов Нобелевской премией. Слева направо: Н. Г. Басов, А. М. Прохоров, Д. В. Скобельцын, М. Д. Миллионщиков. ФИАН, 1964 г.

Celebrations on the occasion of awarding the Nobel Prizes. Left to right: N. G. Basov, A. M. Prokhorov, D. V. Skobeltsyn, and M. D. Millionshchikov, FIAN. 1964.

THE ONE WHO DEFENDED QUANTUM ELECTRONICS

D. V. Skobeltsyn had a unique ability to understand the work of others, and a remarkable ability to distinguish the main thing to be developed. He timely assessed the prospects of quantum electronics and provided, perhaps, major support for this branch of science. As confirmation of this fact, here is a not very well-known episode from the history of the domestic quantum electronics.

At the end of 1964 (after the Nobel Prize awarding), at one of the meetings of the Presidium of the Academy of Sciences, it was proposed to transfer work on quantum electronics from FIAN to industrial structures. D. V. Skobeltsyn was one who opposed strongly that proposal.

In his speech he unequivocally rejected the claim that there was nothing more for physicists to do in the field of quantum electronics.

Recalling how many important achievements were made at FIAN in this field in subsequent years, one can only be amazed again and again how far-seeing Skobeltsyn was. It is difficult to overestimate the role of Dmitry Vladimirovich Skobeltsyn, a nuclear scientist and a founder of high-energy physics, who defended quantum electronics and modern optics at FIAN. *(N. G. Basov, N. A. Dobrotin, A. I. Isakov)*

А. М. Прохоров и Н. Г. Басов на обложке журнала «Советский Союз» за декабрь 1964 года.

A. M. Prokhorov and N. G. Basov on the cover page of the magazine «Soviet Union», December 1964.

Праздник в ФИАНе по поводу присуждения Нобелевской премии сотрудникам – Н. Г. Басову и А. М. Прохорову.

Celebrations in the Lebedev Institute on the occasion of awarding the Nobel Prize to N. G. Basov and A. M. Prokhorov.

COSTUME PERFORMANCE

Alexander Mikhailovich and Nikolai Gennadievich were honored at a large banquet with comic scenes, where our employees played the roles of the Swedish king, queen and their retinue. Speeches were written for everyone, everything was very solemn. Later on, there was a feast with jokes, songs, dances, everything was like at any banquet on some occasion: Barchukov sang romances (he could sing very well), Lida Kalchenko sang her favorite lyric song. Lyova Kulevsky sang so that you listen (after all, he studied with Baturin, the singer of the Bolshoi Theater) and, I think, only because of his eyesight he did not sing on the professional scene. And how to forget the singing of Rolka Shabansky or the singing of Volodya Cheremisinov, the Conservatory graduate, a wonderful tenor and pianist… *(T. M. Murina)*

Виновники торжества – Н. Г. Басов и А. М. Прохоров.

The heroes of the occasion: N. G. Basov and A. M. Prokhorov.

На даче Прохоровых в Перхушково. Слева направо: Н. Г. Басов, Ч. Таунс, жена А. И. Барчукова, К. Т. Басова, Г. А. Прохорова, В. Г. Веселаго, А. М. Прохоров, супруга Таунса Френсис, Кирилл Прохоров. 1965 г.

Prokhorovs' dacha in Perkhushkovo. Left to right: N. G. Basov, Ch. Townes, the wife of A. I. Barchukov, K. T. Basova, G. A. Prokhorova, V. G. Veselago, A. M. Prokhorov, Frances, the wife of Ch. Townes, and Kirill Prokhorov, 1965.

FANTASY OF SCIENTISTS

Townes' main works are devoted to radio-spectroscopy, quantum electronics and its applications, nonlinear optics, radio-astronomy. Charles Hard Townes, independently of A. M. Prokhorov and N. G. Basov, put forward the idea of a new principle of generation and amplification of electromagnetic waves and on its basis, together with his colleagues, created the first quantum oscillator – a maser on ammonia, 1954. In 1958, together with A. Schawlow he substantiated and patented the possibility of developing an optical quantum oscillator.

Townes applied the methods of quantum electronics and nonlinear optics for astrophysics and, in 1969, together with others, discovered the maser effect in space.

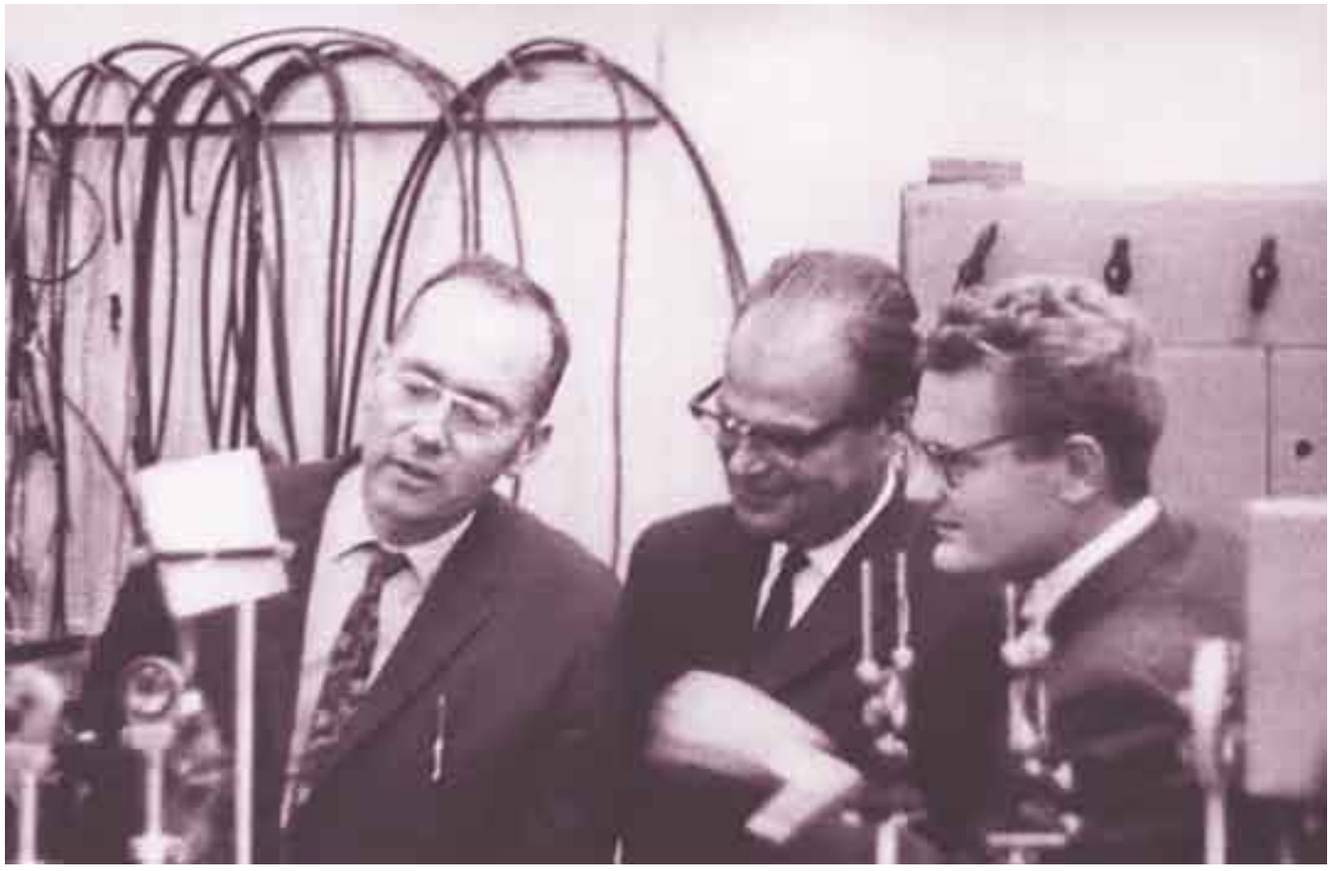
In his interview to Annie Jacobson, the journalist, Charles Townes said that A. N. Tolstoy's book «The Hyperboloid of Engineer Garin» *(also known in English as «The Garin Death Ray» – ed. remark)*, published in 1936, inspired him to invent the laser. All the years that followed after the Nobel Prize award, Townes was in touch with his partners for the prize – A. M. Prokhorov and N. G. Basov.

PIONEERS

N. G. Basov and A. M. Prokhorov in the USSR and the author of these lines in the USA were the first to undertake serious attempts to develop devices for obtaining amplification under stimulated emission, that is, to create devices that are now called masers and lasers. Their ideas and developments in the field of quantum electronics have played a decisive role in the development of this field in both science and technology. *(C. H. Townes)*

BREAKTHROUGHS DETERMINING THE 20TH CENTURY PROGRESS

<…> I would like to quote the words of another great scientist, Nobel Prize Winner Zhores Ivanovich Alferov. In his opinion, three discoveries in the field of physics determined the technological and social progress of the twentieth century. The first one was the fission of uranium, discovered by the German scientists Gann and Strassmann in 1938; the second one was the invention of transistors by John Bardeen, Walter Brattain and William Shockley in 1947, which paved the way for computer revolution. And the third one was the discovery by Nikolai Basov, Alexander Prokhorov and Charles Townes of the laser-maser principle, which gave an impetus to the development of many military and civil technologies. And first of all, these are semiconductor lasers and fiber-optic communication. *(V. V. Apollonov)*



Ч. Таунс в ФИАНе. Осмотр лабораторий. Слева направо: Ч. Таунс, Н. Г. Басов, А. З. Грасюк. Сентябрь 1965 г.

Ch. Townes visits a lab at the Lebedev Institute, left to right: Ch. Townes, N. G. Basov, A. Z. Grasyuk. 1965.

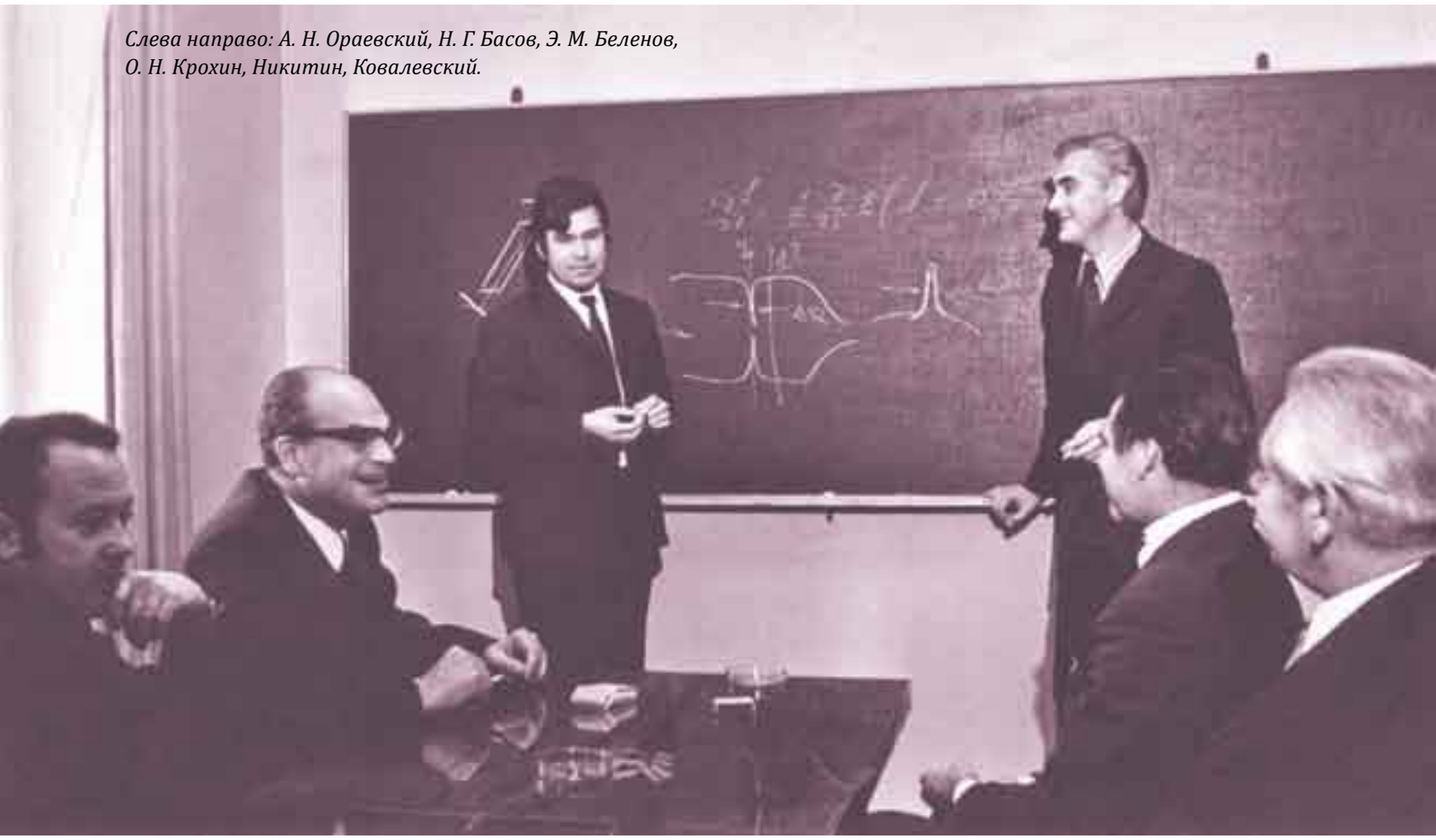
На семинаре по квантовой электронике в первый приезд Ч. Таунса в ФИАН. Слева направо: Г. М. Страховский, А. Н. Ораевский, А. М. Прохоров, Н. Г. Басов, Ч. Таунс. Москва, сентябрь 1965 г.

At the seminar on quantum electronics during the first Ch. Townes visit to the Lebedev Institute. Left to right: G. M. Strakhovsky, O. N. Oraevsky, A. M. Prokhorov, N. G. Basov, Ch. Townes.

AFTER NOBEL PRIZE HOLIDAY

The holiday ended, and a very difficult period in life began for Nikolai Gennadievich. The fact is that he immediately became very much in demand. He was literally torn to pieces. Endless invitations began, speeches, promotion to various posts. He had many public duties. But in his head, there was FIAN, and only FIAN, as well as his «brainchild» – the Quantum Radiophysics Division. *(K. T. Basova)*

Слева направо: А. Н. Ораевский, Н. Г. Басов, Э. М. Беленов, О. Н. Крохин, Никитин, Ковалевский.



Left to right: A. N. Oraevsky, N. G. Basov, E. M. Belenov, O. N. Krokhin, V. V. Nikitin, and D. V. Kovalevsky.

На семинаре. На первом ряду у окна сидят (слева направо): А. Н. Ораевский, В. Б. Розанов, Н. Г. Басов, И. И. Собельман, О. Н. Крохин. 1966 г.

At the seminar: A. N. Oraevsky, V. B. Rozanov, N. G. Basov, I. I. Sobel'man and O. N. Krokhin are sitting in the first row, 1966.

DUTY OF A SCIENTIFIC LEADER

Young people are the subject of special concern for Nikolai Gennadievich. In his opinion, true progress in work is possible only when the growth rate of new scientific ideas is ahead of the rate of actual growth of the team of scientists. This gap should be compensated by the influx of young people who, coming to science, find themselves at the center of the main scientific activity and have good growth prospects. It is this circumstance that allows young people to quickly become independent and form a large well-coordinated team. And the duty of the supervisor to focus on the weak links of the team. *(D. V. Skobeltsyn)*

Behind every idea of N. G. Basov is the creative work of his students. Basov has a lot of students. His scientific school enlists about 60 PhD's. They are all interesting and bright personalities, in many ways not similar to their teacher. All of them are united by the desire to search for something new. *(A. N. Oraevsky)*

PHYSICAL INTUITION

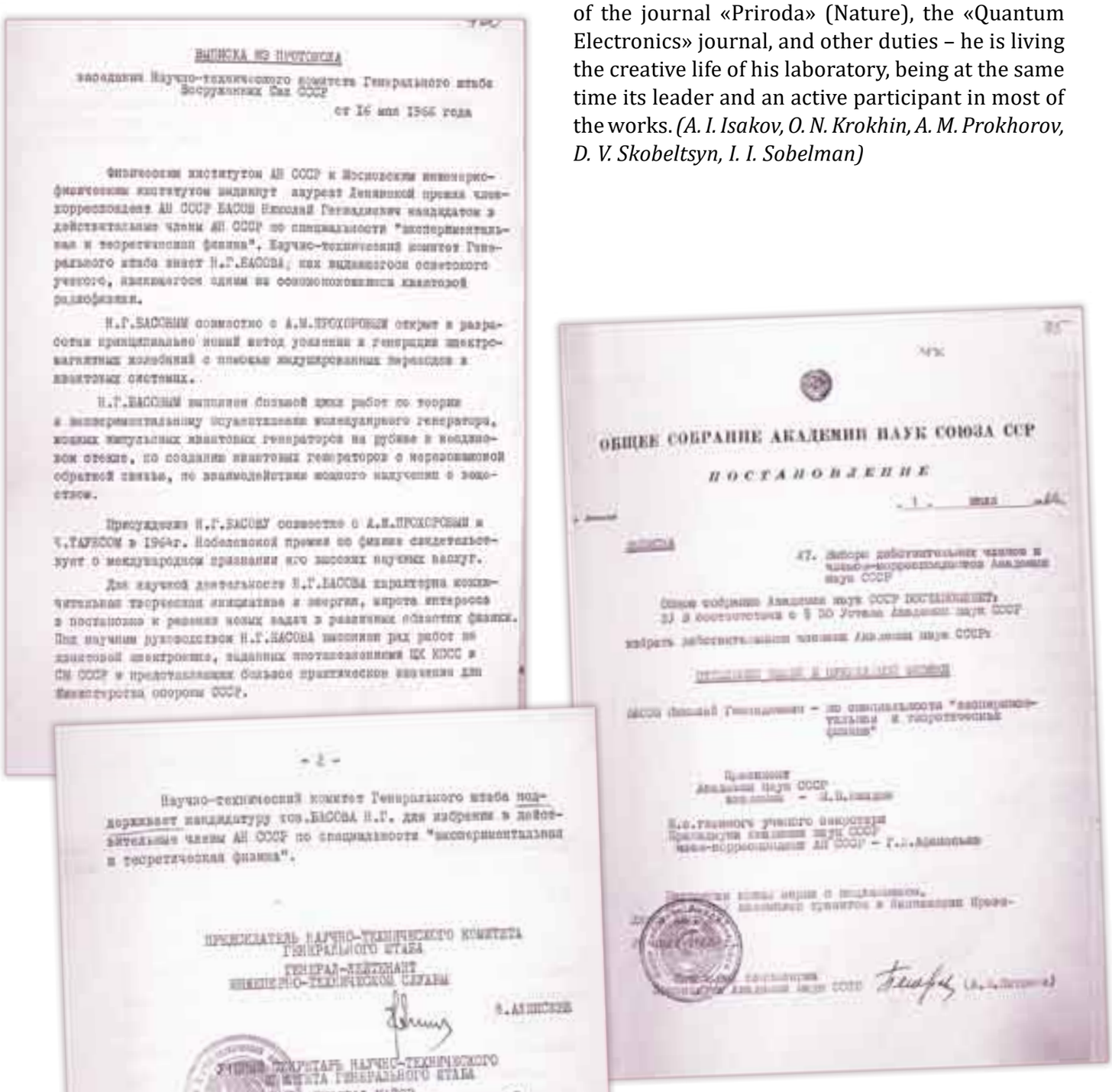
The scientific activity of N. G. Basov played a vital role in the formulation of many problems dealing with the development of quantum electronics. Everyone who had had a chance to talk about science with Basov remarked his unusual physical intuition, the ability to discern the future of the problem through the fog of the present day. One of the examples is his deep insight into the problem of the coherence of induced transitions. *(A. N. Oraevsky)*

За выдающиеся научные достижения Н. Г. Басов в 1966 году был избран действительным членом АН СССР. С 1967 по 1990 год он – член Президиума Академии наук, а с 1990 года – советник Президиума РАН.

For outstanding scientific achievements N. G. Basov was elected in 1966 as a full member of the USSR Academy of Sciences. From 1967 to 1990 he was a member of the Praesidium of the USSR Academy of Sciences, and since 1990, the adviser to the Praesidium of the Russian Academy of Sciences.

Выписка из протокола и постановление об избрании Н. Г. Басова действительным членом АН СССР. 1966 г.

Protocol and the resolution on the election of N. G. Basov as a full member of the USSR Academy of Sciences, 1966.



ВЫПИСКА ИЗ ПРОТОКОЛА

заседания Научно-технического комитета Генерального штаба Вооруженных Сил СССР

от 16 мая 1966 года

Физическим институтом АН СССР и Московским инженерно-физическим институтом выдвинут лауреат Ленинской премии член-корреспондент АН СССР БАСОВ Николай Геннадиевич кандидатом в действительные члены АН СССР по специальности "экспериментальная и теоретическая физика". Научно-технический комитет Генерального штаба знает Н.Г.БАСОВА, как выдающегося советского ученого, являющегося одним из основоположников квантовой радиофизики.

Н.Г.БАСОВЫМ совместно с А.М.ПРОХОРОВЫМ открыт и разработан принципиально новый метод усиления и генерации электромагнитных колебаний с помощью индуцированных переходов в квантовых системах.

Н.Г.БАСОВЫМ выполнен большой цикл работ по теории и экспериментальному осуществлению молекулярного генератора, мощных импульсных квантовых генераторов на рубине в инфракрасном спектре, по созданию квантовых генераторов с неравновесной обратной связью, по взаимодействию мощного излучения с веществом.

Присуждение Н.Г.БАСОВУ совместно с А.М.ПРОХОРОВЫМ и Ч.ТАУНСОМ в 1964г. Нобелевской премии по физике свидетельствует о международном признании его высоких научных заслуг.

Для научной деятельности Н.Г.БАСОВА характерна конкретная творческая инициатива и энергия, широта интересов в постановке и решении новых задач в различных областях физики. Под научным руководством Н.Г.БАСОВА выполнен ряд работ по квантовой электронике, выданных постановлениями ЦК КПСС и СМ СССР и представляющих большое практическое значение для министерства обороны СССР.

- 2 -

Научно-технический комитет Генерального штаба поддерживает кандидатуру тов.БАСОВА Н.Г. для избрания в действительные члены АН СССР по специальности "экспериментальная и теоретическая физика".

ПРЕДСЕДАТЕЛЬ НАУЧНО-ТЕХНИЧЕСКОГО КОМИТЕТА
ГЕНЕРАЛЬНОГО ШТАБА
ГЕНЕРАЛ-ЛЕЙТЕНАНТ
ИНЖЕНЕРНО-ТЕХНИЧЕСКОЙ СЛУЖБЫ
В.АЗИЕВСКИЙ

УЧЕНЫЙ СЕКРЕТАРЬ НАУЧНО-ТЕХНИЧЕСКОГО КОМИТЕТА ГЕНЕРАЛЬНОГО ШТАБА
ГЕНЕРАЛ-МАЙОР
ИНЖЕНЕРНО-ТЕХНИЧЕСКОЙ СЛУЖБЫ
В.ВАСИЛЬЕВ

ОБЩЕЕ СОБРАНИЕ АКАДЕМИИ НАУК СОЮЗА ССР

ПОСТАНОВЛЕНИЕ

- 1 - мая -66

СЛУШАЛИ

47. Выборы действительных членов и членов-корреспондентов Академии наук СССР

Общее собрание Академии наук СССР ПОСТАНОВЛЯЕТ:

1) в соответствии с § 20 Устава Академии наук СССР

избрать действительными членами Академии наук СССР:

по специальности "экспериментальная и теоретическая физика"

Президент
Академии наук СССР
академик - М.В.Келдыш

Ученый секретарь
Президиума Академии наук СССР
член-корреспондент АН СССР - Г.Н.Аделькин

IN CREATIVE SEARCH

The creative path of N. G. Basov is the path of a scientist who devoted all his time and talent to the development of national science. Now N. G. Basov is the head of a large research team united in the Quantum Radiophysics laboratory.

Almost all laboratory staff are young people, brought up by him from their student years.

Despite his numerous duties – the deputy director of the institute, a member of the Presidium of the USSR Academy of Sciences, a member of the Higher Attestation commission, editor-in-chief of the journal «Priroda» (Nature), the «Quantum Electronics» journal, and other duties – he is living the creative life of his laboratory, being at the same time its leader and an active participant in most of the works. *(A. I. Isakov, O. N. Krokhin, A. M. Prokhorov, D. V. Skobeltsyn, I. I. Sobelman)*

Talent, constant scientific creative work and the search for something new, the ability to combine the interests of scientific research with practical usefulness of the results – these are the characteristic features of N. G. Basov.

If we try to evaluate the personal contribution of N. G. Basov to quantum radiophysics and related branches of science, it turns out to be extremely high – only a small number of scientific directions in this area were not influenced by him.

At the same time, it is practically impossible to name any of the most important branches of modern quantum radiophysics, which would not have been developed by N. G. Basov and his team. (*A. I. Isakov, O. N. Krokhin, A. M. Prokhorov, D. V. Skobeltsyn, I. I. Sobelman)*

И. Е. Тамм, Н. Г. Басов, В. Л. Гинзбург на юбилее А. М. Прохорова.
I. E. Tamm, N. G. Basov, V. L. Ginzburg at the jubilee of A. M. Prokhorov.

Н. Г. Басов, ?, В. Л. Гинзбург на юбилее А. М. Прохорова.

N. G. Basov,?, V. L. Ginzburg at the jubilee of A. M. Prokhorov.

Ксения Тихоновна и Николай Геннадиевич Басовы на 50-летии Александра Михайловича Прохорова. 11 июля 1966 г.

Kseniya Tikhonovna and Nikolai Gennadievich at the 50th Jubilee of Alexander Mikhailovich Prokhorov, July 11, 1966.

«TYPICAL REPRESENTATIVE OF THE SOVIET ERA»

Nikolai Gennadievich never seemed to be «high and mighty». Climbing the social ladder he did not change, remained an open and accessible person. He never needed money, he was the director of a large institute, drove a black car «Volga», he was given an apartment. Although he was, of course, a typical representative of the Soviet era with all its shortcomings. Before the authorities, for example, he behaved very law-abiding. And with his subordinates he remained democratic, even too much. And, perhaps, was not very demanding enough with the staff.

Physicists are special people, but they also like to have fun. For example, N. G. Basov loved to celebrate his birthdays. As expected, with vodka and snacks. By the way, he liked to drink. He used to say: «What a Russian does not like to drink», and always celebrated his birthdays at the institute. For jubilees he used to invite friends home. We drank champagne, then came stronger drinks. True, later he was drinking less and less alcohol. And he gave up smoking. *(Yu. M. Popov)*

Отчет Н. Г. Басова, руководителя Лаборатории квантовой радиофизики, перед сотрудниками.

Report of N. G. Basov, the Head of the Quantum Radiophysics Laboratory, to employees.

AS A LASER

Basov. A scientist with a worldwide reputation. He rightfully occupies an honorable place in the list of the most outstanding scientists. And at the same time, he has the art of not emphasizing his intellectual superiority and is being nice to talk to.

Restrained. Modest to the point of shyness. When he listens – absorbs every word.

Likes to joke. Subtly appreciates the humor of the situation. He laughs in a bass voice, as if justifying his surname, just explodes with laughter.

And he has one more feature. I have not seen it with other people. Anyway, expressed so clear.

Here he is – smiling, listening, being silent. But you even feel it, that he is like being charged with some internal energy. The eyes darken and become very deep. Crossing the room with wider steps. From corner to corner.

And suddenly, like lightning, a phrase-aphorism, as if he was discharged. And again, he sits silent gaining strength.

Once, at the institute, when Basov's optical quantum oscillator was turned on and the glass tube began to blush, blush, as if preparing for a very difficult job, and then it «shot» with a thin ray, I thought: «Where have I seen something like that?»

And suddenly I realized: «Well, yes. Basov, of course. He's like the laser himself. “

I wanted to immediately share my «discovery» with the fellow-physicists, but remembering the behavior of the laser, made a solid pause before blurting out the phrase.

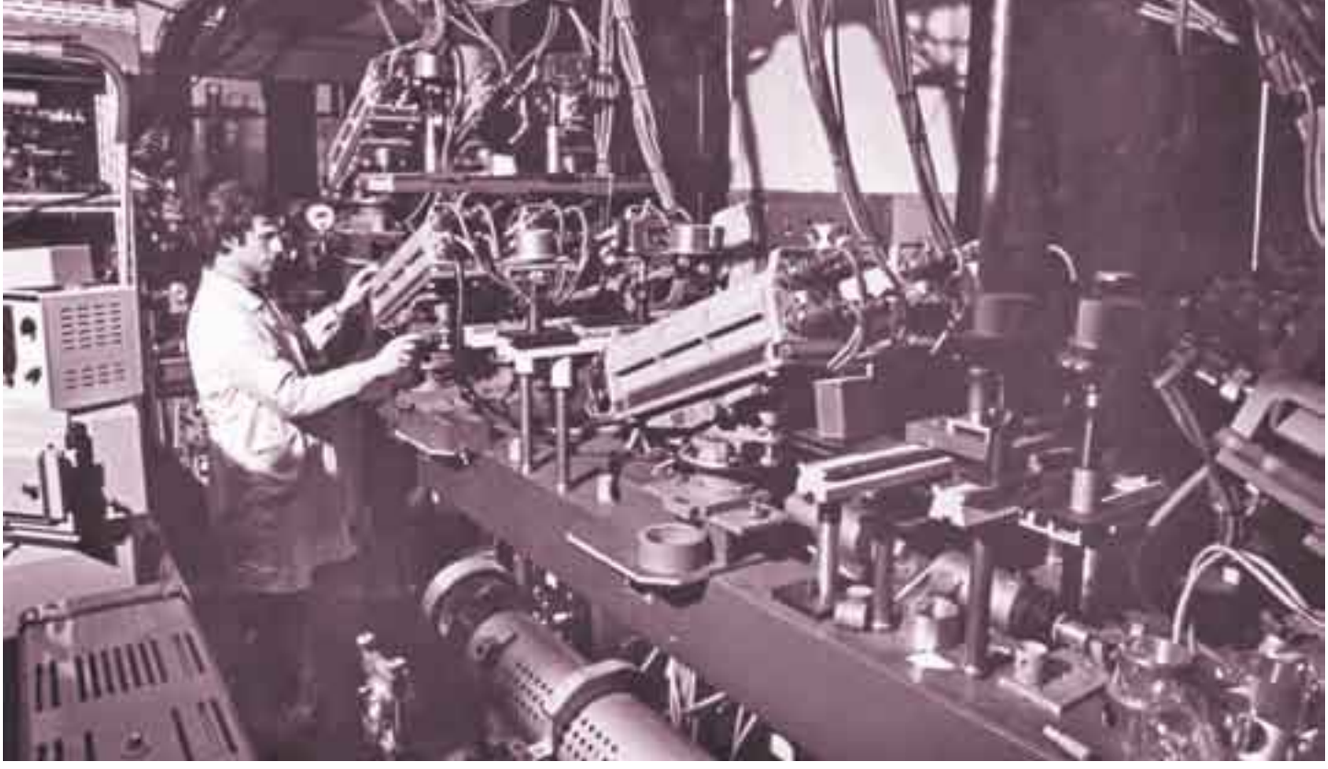
Blasted out.

Physicists also thought and thought, then nodded their heads in sync:

– Looks like.

And then we also thought about it and, through collective efforts, brought a theoretical base under the stated thesis.

Man expresses himself in his works. Tchaikovsky even outwardly resembles his music, soft and lyrical. Beethoven – powerful and heroic. And Leo Tolstoy? At first glance, you would say that only such a human being could write «War and Peace». So why shouldn't a laser be like its master? *(V. V. Anikeev)*



Девятиканальная мощная лазерная установка на неодимовом стекле «Кальмар», предназначенная для получения плазмы с термоядерными параметрами.

The «Kalmar» 9-channel powerful laser facility on neodymium glass intended to produce plasma with thermonuclear characteristics.

LASER THERMONUCLEAR FUSION

The first public speech of N. G. Basov on the use of laser radiation for heating the plasma to high temperatures, when a thermonuclear reaction becomes possible, was his presentation at the meeting of the Presidium of the USSR Academy of Sciences in 1962. Then in 1964 followed the publication of the paper «Conditions for plasma heating by the optical oscillator radiation» in ZhETP written together with O. N. Krokhin. In 1968, Basov and co-workers carried out the first experiment on plasma heating by laser pulses of 10^{-11}s duration. They managed to heat a specially prepared target (a small ball) of thermonuclear fuel up to the temperatures of thermonuclear synthesis and observe thermonuclear neutrons. (P. G. Kryukov, S. D. Zakharov, Yu. V. Senatsky).

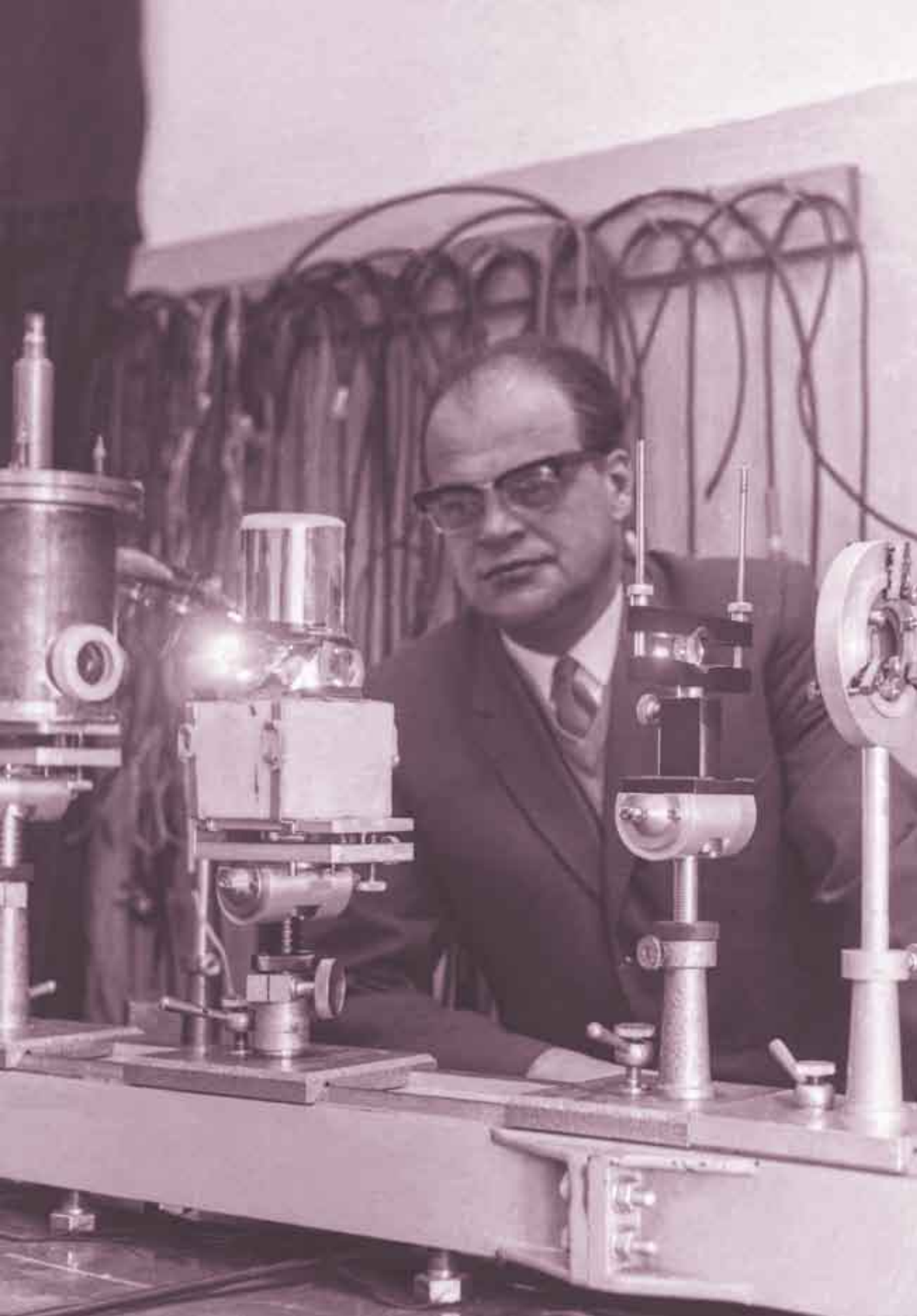
These ideas and results were picked up by many groups of researchers around the world, giving rise to a wide scientific direction.

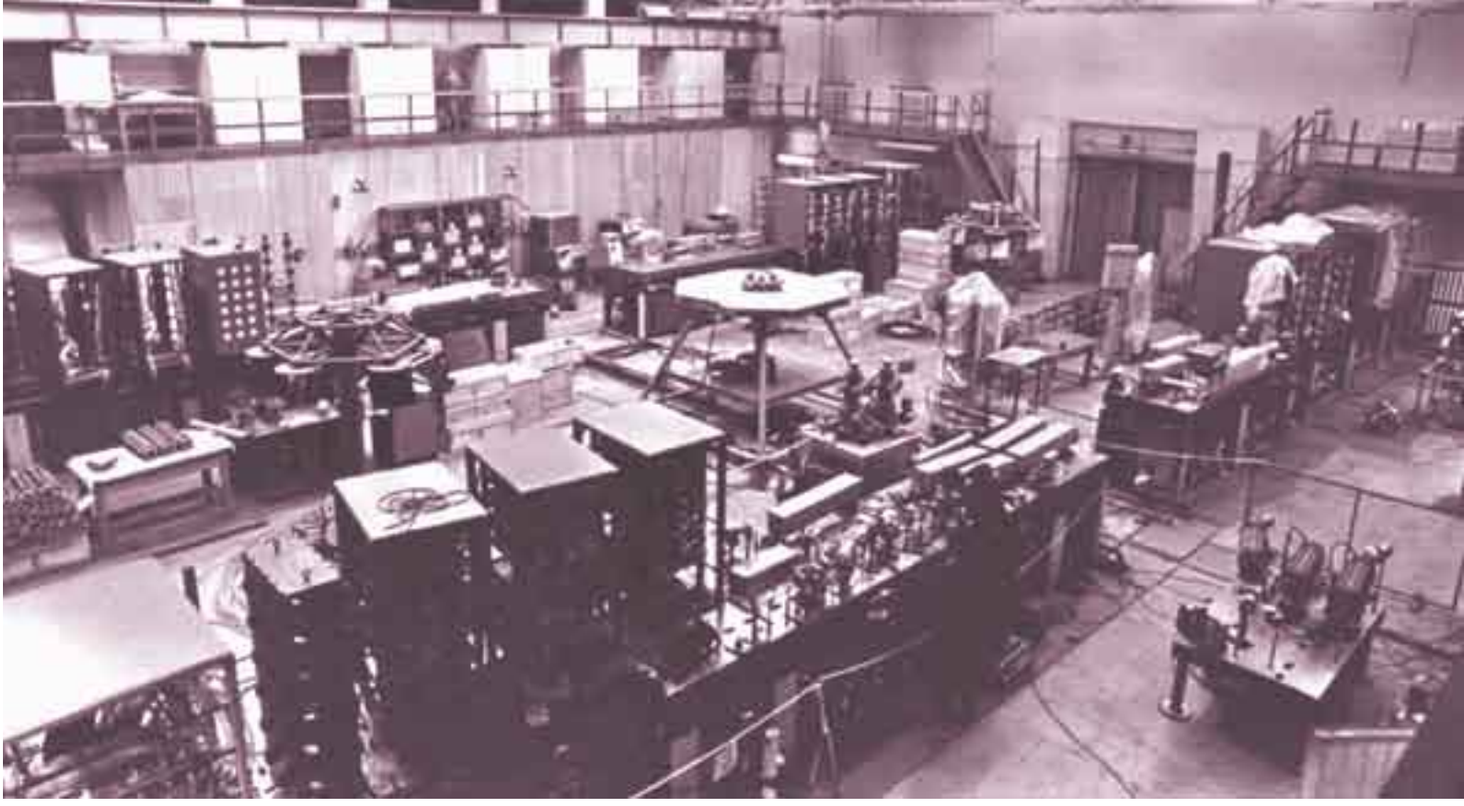
It includes the development of high-power pulsed lasers, the study of plasma produced under the action of a high-power laser pulse interaction with matter, and the development of approaches for solving the problem of thermonuclear energy control.

In the early 70s, under the leadership of N. G. Basov (G. V. Sklizkov, A. V. Shikanov, et al.) the world's first multichannel laser facility for spherical irradiation of thermonuclear targets was mounted. The laser was named «Kalmar» and under that name became widely known. Target compression up to high densities under spherical irradiation was demonstrated on that setup and the thermonuclear neutrons were produced due to target compression and heating. Then these works became widely known (USA, Japan, France). Basov's goal was to develop a program of international collaboration in this field of research. *(A. N. Oraevsky)*

Слева направо: молодые учёные П. Г. Крюков, Ю. В. Сенатский, С. Д. Захаров – лауреаты Премии Ленинского комсомола в 1970 году – за разработку метода генерации мощных лазерных импульсов и использование их для высокотемпературного нагрева плазмы.

Left to right: young scientists P. G. Kryukov, Yu. V. Senatsky and S. D. Zakharov – Lenin Komsomol Prize Winners in 1970 for the development of the method of producing high-power laser pulses and their application for high-temperature plasma heating.





Установка «Дельфин». Октябрь 1975 г.

Installation «Dolphin». October 1975.

«CALAMARY» AND «DOLPHIN» FACILITIES

In 1974, together with scientists from the Keldysh Institute of Applied Mathematics, we proposed an alternative scheme for low-entropy compression using a time-uniform laser pulse and nonhomogeneous high-aspect ratio targets. (Yu. V. Afanasyev, N. G. Basov, P. P. Volosevich, E. G. Gamaliy, O. N. Krokhin, S. P. Kurdyumov, E. I. Levanov, V. B. Rozanov, A. A. Samarsky, A. N. Tikhonov).

During the years that followed, a large cycle of experimental studies on shell target compression was carried out on the «Calamary» *(Kalmar in Russian – ed. remark)* installation, which fully justified the chosen approach (N. G. Basov, G. V. Sklizkov, A. S. Shikanov et al.). We believed that the main problem of laser thermonuclear fusion with the use of thin shells is associated with compression stability.

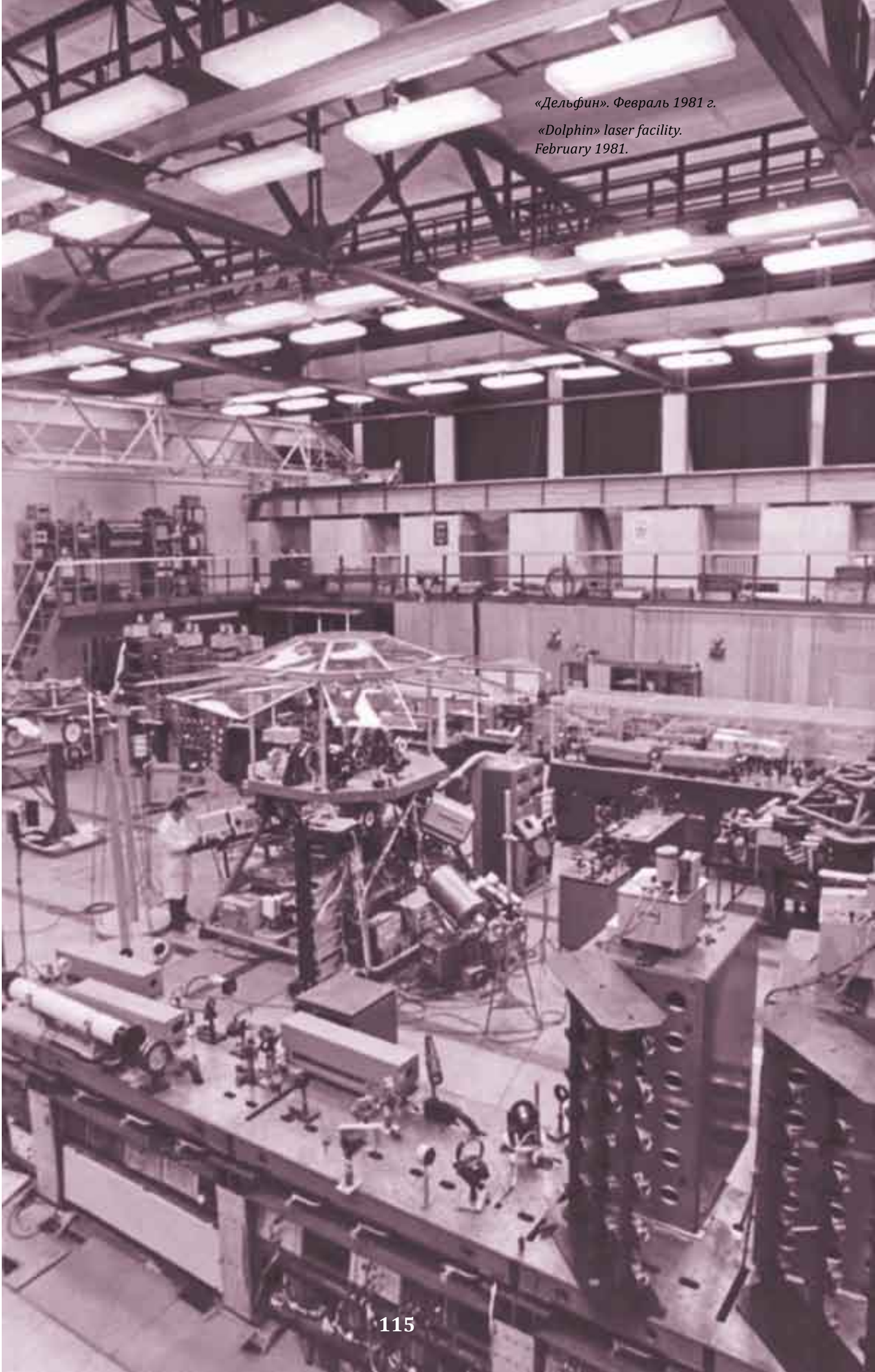
Together with the theoretical and numerical studies, in the late 70s – early 80s years,

Н. Г. Басов, Г. В. Склизков, С. П. Федотов и Ю. А. Михайлов.

N. G. Basov, G. V. Sklizkov, S. P. Fedotov and Yu. A. Mikhailov.

experiments were carried out on the 108-channel installation «Dolphin» *(«Delfin» in Russian – ed. remark)* that was mounted in 1982 for the compression of shells with an aspect ratio of ~ 100. In those experiments, it became possible to achieve 3×10^3-fold compression, which demonstrated a feasibility of stable compression of such targets (N. G. Basov, G. V. Sklizkov, S. I. Fedotov and others).

We believe that the main issues here are a further development of the physics of thermonuclear targets, especially in the field of compression, the choice and creation of a driver for laser fusion, the engineering and technical development of a laser thermonuclear reactor, and ultimately, the project development for a laser thermonuclear power plant that should be technically feasible, economically viable, and safe for people and the environment. *(N. G. Basov)*



«Дельфин». Февраль 1981 г.

«Dolphin» laser facility. February 1981.

Слева направо: О. Н. Крохин, И. И. Собельман, Ф. С. Файзуллов, академик Н. Г. Басов, Ю. М. Попов, А. З. Грасюк, А. Ф. Плотников и С. И. Федотов. Октябрь 1975 г.

From left to right: O. N. Krokhin, I. I. Sobelman, F. S. Fayzullov, academician N. G. Basov, Yu. M. Popov, A. Z. Grasyuk, A. F. Plotnikov and S. I. Fedotov. October 1975.

Н. Г. Басов и Г. Веларде в ФИАНе. На заднем плане сотрудники ФИАН И. Г. Лебо (слева) и Г. А. Вергунова (справа).

N. G. Basov and G. Velarde at the Lebedev Institute and FIAN's scientists I. G. Lebo (left), G. A. Vergunova (right).

In experiments that began in FIAN in 1982, Basov, Sklizkov and Fedotov demonstrated the possibility of stable compression of shell targets with an aspect ratio of 100, reaching a density of 8 g/cm^3 using the 108-channel «Delfin» laser facility. Similar experiments, but at high energies, were carried out by Yamanaka's group at Osaka University. *(G. Velarde)*

На фоне установки «Дельфин» в Лаборатории лазерной плазмы.

Scientists of Laser plasma Lab in front of «Dolphin» laser facility.

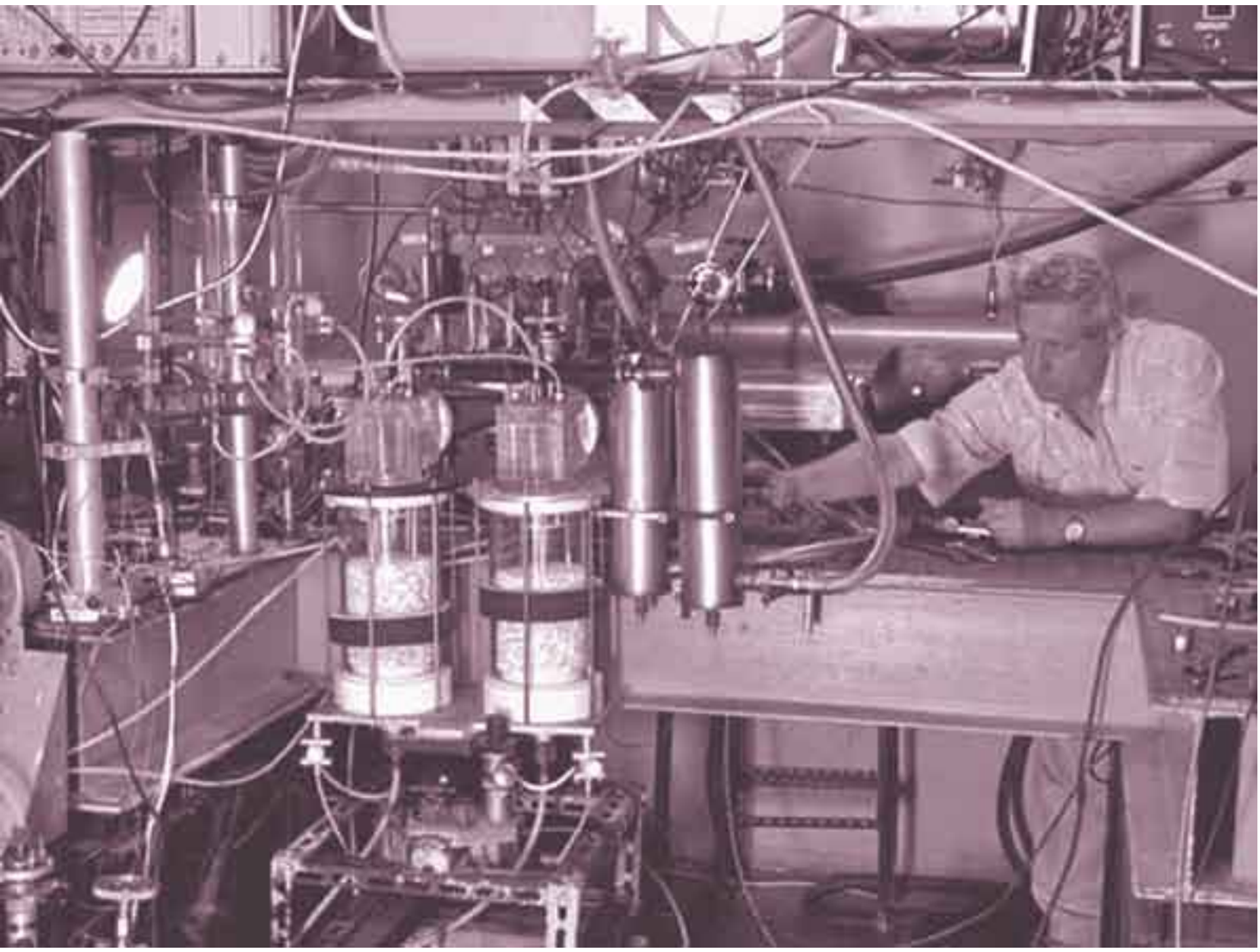
Е. П. Маркин за исследованием кольцевого газового лазера. 27 декабря 1967 г.

E. P. Markin studies a ring gas laser, December 27, 1967.

THE IDEA OF DEVELOPING GAS-DYNAMIC AND CHEMICAL LASERS

In essence, a laser is a device that converts various types of energy into coherent light (electromagnetic radiation) energy. Following the creation of the first lasers, the possibility of direct conversion of thermal and chemical energy into laser radiation was discussed. Initial ideas on using solid-state materials for this purpose were of no success. In 1963, Basov and Oraevsky proposed to try molecular gases for this purpose. Ultimately, it was on this path that it became possible to demonstrate a heat-pumped laser, called a gas-dynamic laser. In the field of chemical lasers, N. G. Basov and co-workers came up with the idea of developing pulsed chemical lasers based on chain reactions and the concept of purely chemical CW lasers. A large series of theoretical and experimental researches in this field was awarded the Lenin Prize in 1984. *(A. N. Oraevsky)*

First pages of N. G. Basov's and A. N. Oraevsky's Certificate of Invention on a chemical laser and scientific paper on a gas-dynamic laser. ▶



Н. Н. Юрышев с кислородно-йодным лазером.

Pulsed chemical oxygen-iodine laser.
N. N. Yuryshev is carrying out the experiment.

Союз Советских Социалистических Республик

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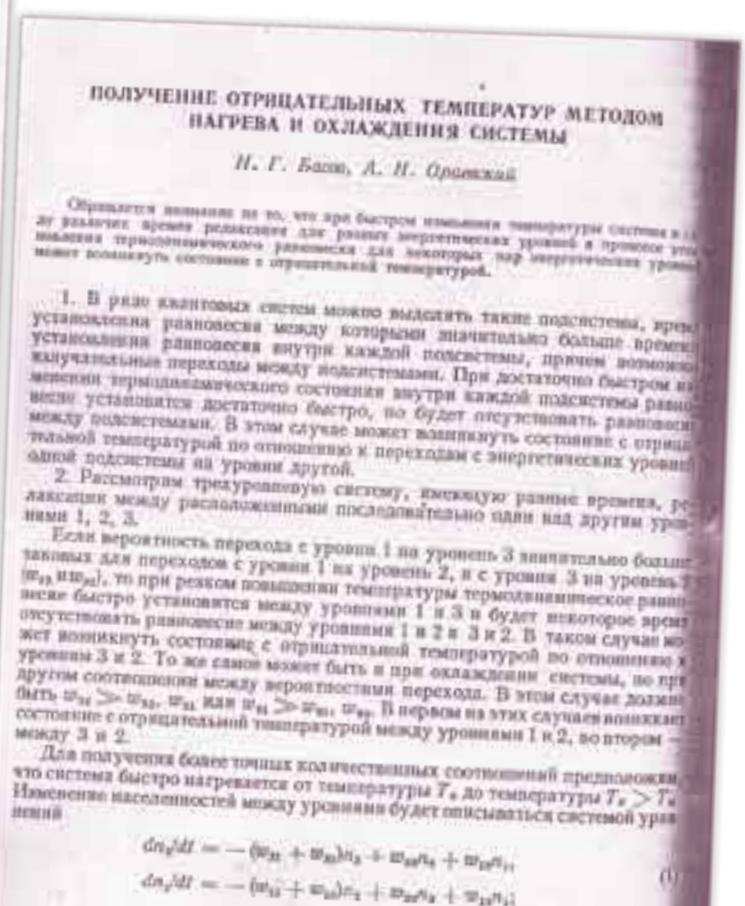
(54) ЛАЗЕР



ПОЛУЧЕНИЕ ОТРИЦАТЕЛЬНЫХ ТЕМПЕРАТУР МЕТОДОМ НАГРЕВА И ОХЛАЖДЕНИЯ СИСТЕМЫ

Н. Г. Басов, А. Н. Ораевский

Обращается внимание на то, что при быстром изменении температуры системы в ... ее различных время релаксации для разных энергетических уровней в процессе этого ... повышения термодинамического равновесия для некоторых пар энергетических уровней ... может возникнуть состояние с отрицательной температурой.

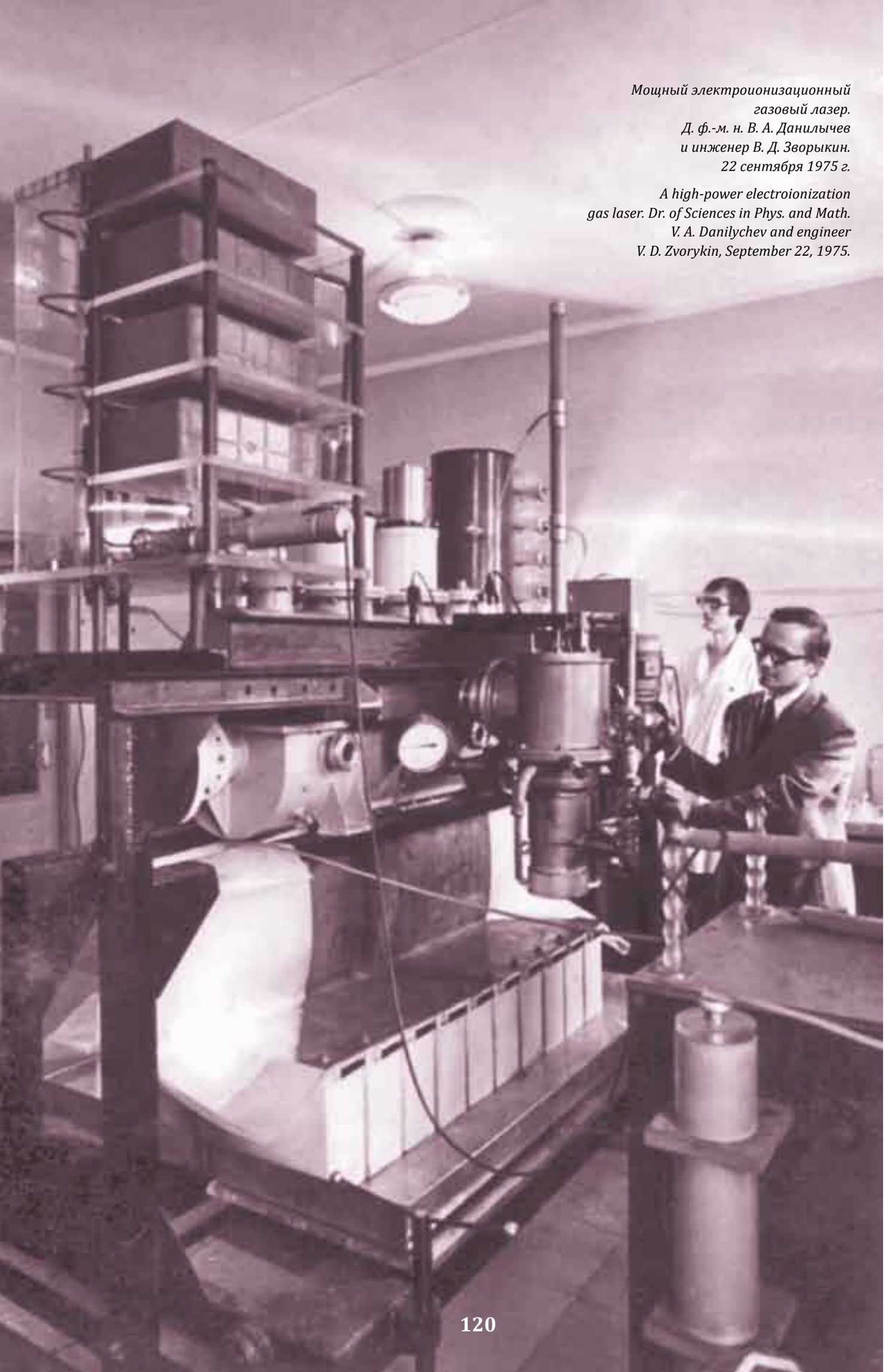
1. В ряде квантовых систем можно выделить такие подсистемы, время ... установления равновесия между которыми значительно больше времен... установления равновесия внутри каждой подсистемы, причем возможны ... излучательные переходы между подсистемами. При достаточно быстром из... менении термодинамического состояния внутри каждой подсистемы равно... весие установится достаточно быстро, но будет отсутствовать равновесие ... между подсистемами. В этом случае может возникнуть состояние с отрица... тельной температурой по отношению к переходам с энергетических уровней ... одной подсистемы на уровни другой.

2. Рассмотрим трехуровневую систему, имеющую равные времена ре... лаксации между расположенными последовательно один над другим уров... нями 1, 2, 3.

Если вероятность перехода с уровня 1 на уровень 3 значительно больше ... таковых для переходов с уровня 1 на уровень 2, и с уровня 3 на уровень 2 ... (w_{13} и w_{32}), то при резком повышении температуры термодинамическое равно... весие быстро установится между уровнями 1 и 3 и будет некоторое время ... отсутствовать равновесие между уровнями 1 и 2 и 3 и 2. В таком случае мо... жет возникнуть состояние с отрицательной температурой по отношению к ... уровням 3 и 2. То же самое может быть и при охлаждении системы, но при ... другом соотношении между вероятностями перехода. В этом случае должно ... быть $w_{12} \gg w_{13}$, w_{31} или $w_{21} \gg w_{23}$, w_{32}. В первом из этих случаев возникает ... состояние с отрицательной температурой между уровнями 1 и 2, во втором — ... между 3 и 2.

Для получения более точных количественных соотношений предположим, ... что система быстро нагревается от температуры T_0 до температуры $T_1 > T_0$. ... Изменение населенностей между уровнями будет описываться системой урав... нений

$$\begin{aligned} dn_1/dt &= -(w_{21} + w_{23})n_1 + w_{12}n_2 + w_{13}n_3 \\ dn_2/dt &= -(w_{12} + w_{32})n_2 + w_{23}n_3 + w_{21}n_1 \end{aligned} \quad (1)$$



Мощный электроионизационный газовый лазер. Д. ф.-м. н. В. А. Данилычев и инженер В. Д. Зворыкин. 22 сентября 1975 г.

A high-power electroionization gas laser. Dr. of Sciences in Phys. and Math. V. A. Danilychev and engineer V. D. Zvorykin, September 22, 1975.

Молодые учёные, выдвинутые на премию Ленинского комсомола: В. В. Савельев, В. А. Долгих, В. А. Соболев, О. М. Керимов, А. А. Ионин. Обсуждение конструкции высокоэнергетичного электроионизационного лазера. 30 октября 1979 г.

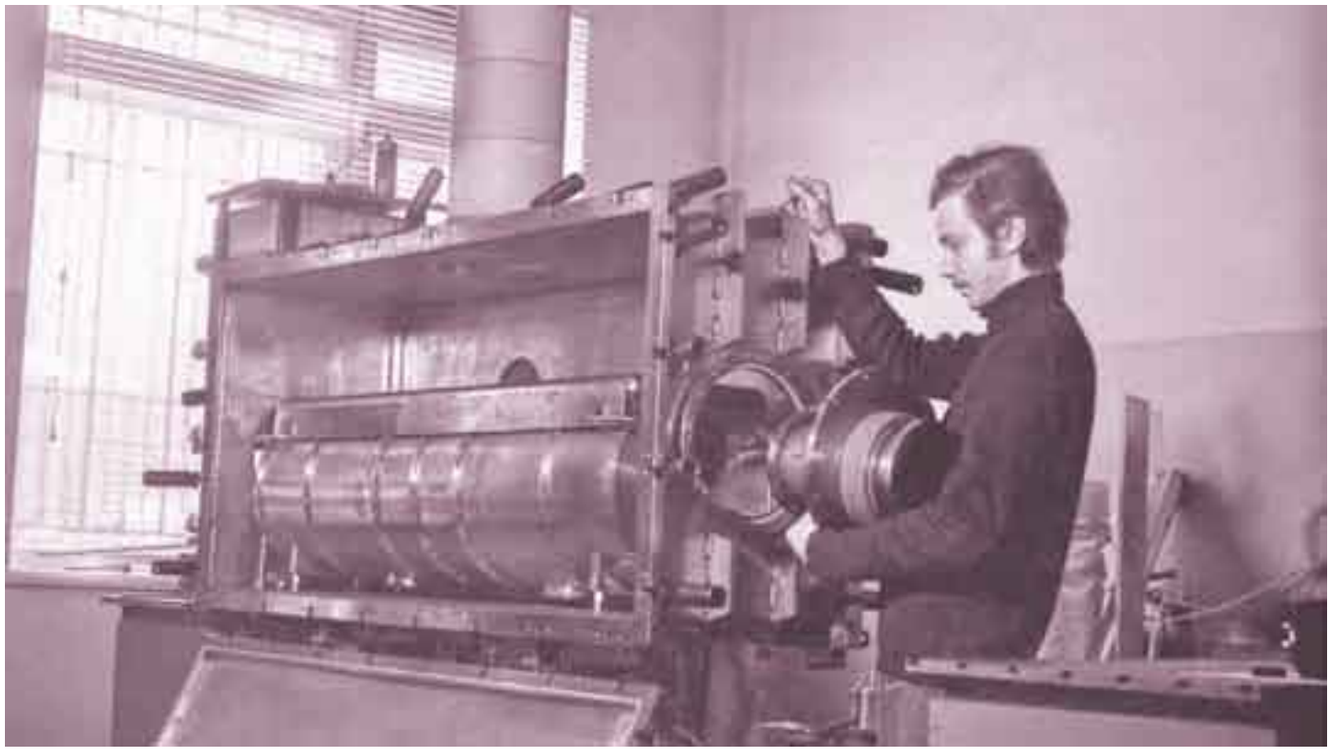
Young scientists nominated for the Lenin Komsomol Prize: (from left to right) V. V. Saveliev, V. A. Dolgikh, V. A. Sobolev, O. M. Kerimov, A. A. Ionin. Discussion on a high-energy electroionization laser design. October 30, 1979

EXCIMER AND ELECTROIONIZATION LASERS

N. G. Basov paid much attention to lasers, in which an electron beam was used to some extent for their pumping. Historically, this development of research can be explained by the presence of an experimental base in the scientific group of N. G. Basov's former PhD student V. A. Danilychev, who previously had dealt with semiconductor lasers pumped by an electron beam. In this group, in 1970, the first excimer laser was launched. An electron beam was used to pump it. The laser, the active medium of which was the Xe_2 dimer formed under the action of a beam in liquid xenon, generated in the VUV region of the spectrum at a wavelength of λ=175 nm. According to A. G. Molchanov (Quantum Electronics, 2003), «it can be said with certainty that the generation observed in 1970 in the laboratory of N. G. Basov took place on several types of excimers at once, including Xe_2^* excimers in gas.» However, no attention was paid to this fact in 1970, and priority was given to the United States, where the compressed xenon excimer laser began operating two years later.

In 1971, N. G. Basov, together with E. M. Belenov, V. A. Danilychev, and A. F. Suchkov, proposed a new type of high-power electric-discharge carbon dioxide laser, which was called an electroionization laser *(It is called an e-beam sustained discharge laser in English – ed. remark)*. The laser is based on a combined pumping, where the number of electrons in the discharge is controlled by an electron beam, and the energy spent on the excitation of molecules is deposited due to the electron acceleration in an external electric field. A non-self-sustained electric discharge arising in this case is not restricted by volume and pressure of the gas, which is typical for self-sustained discharges.

This circumstance made it possible to uniformly excite large volumes of gas at high pressures (up to tens of atmospheres). In electroionization lasers, extremely high values of specific energy output and efficiency are reached, and there is a possibility of frequency tuning due to the wide gain bandwidth associated with high gas density. Studies of pulsed electroionization (EI) CO_2 and CO lasers performed by Basov with co-workers at FIAN, made a scientific foundation for the development of CO_2 and CO lasers operating in continuous and repetitively-pulsed modes. Industrial EI CO_2-lasers of 20–30 kW output power for technological applications were developed in some industrial organizations under his scientific supervision. He also initiated the construction of a high-power pulse-repetition CO_2 laser facility with average output power of 1 MW and angular divergence close to the diffraction one.



Импульсный электроионизационный молекулярный газовый лазер КЛИН-У.
Монтаж установки ведёт Д. В. Синицын.

Pulsed electroionization molecular gas laser Klin-U.
The assembling of the installation is conducted by D. V. Sinitsyn.

CONVERTERS OF LASER EMISSION

Early experimental work on high-power lasers carried out in the early 60s, showed that it is often very difficult to combine high power of laser radiation with its high quality, for example, with low angular divergency of the laser beam.

In this regard, N. G. Basov put forward a fruitful idea of a laser radiation converter.

Such converters are lasers pumped by radiation of other lasers whose beam quality is desirable to improve. The first experiments in this direction were carried out within the framework of the program on pumping semiconductor lasers by radiation from other types of lasers.

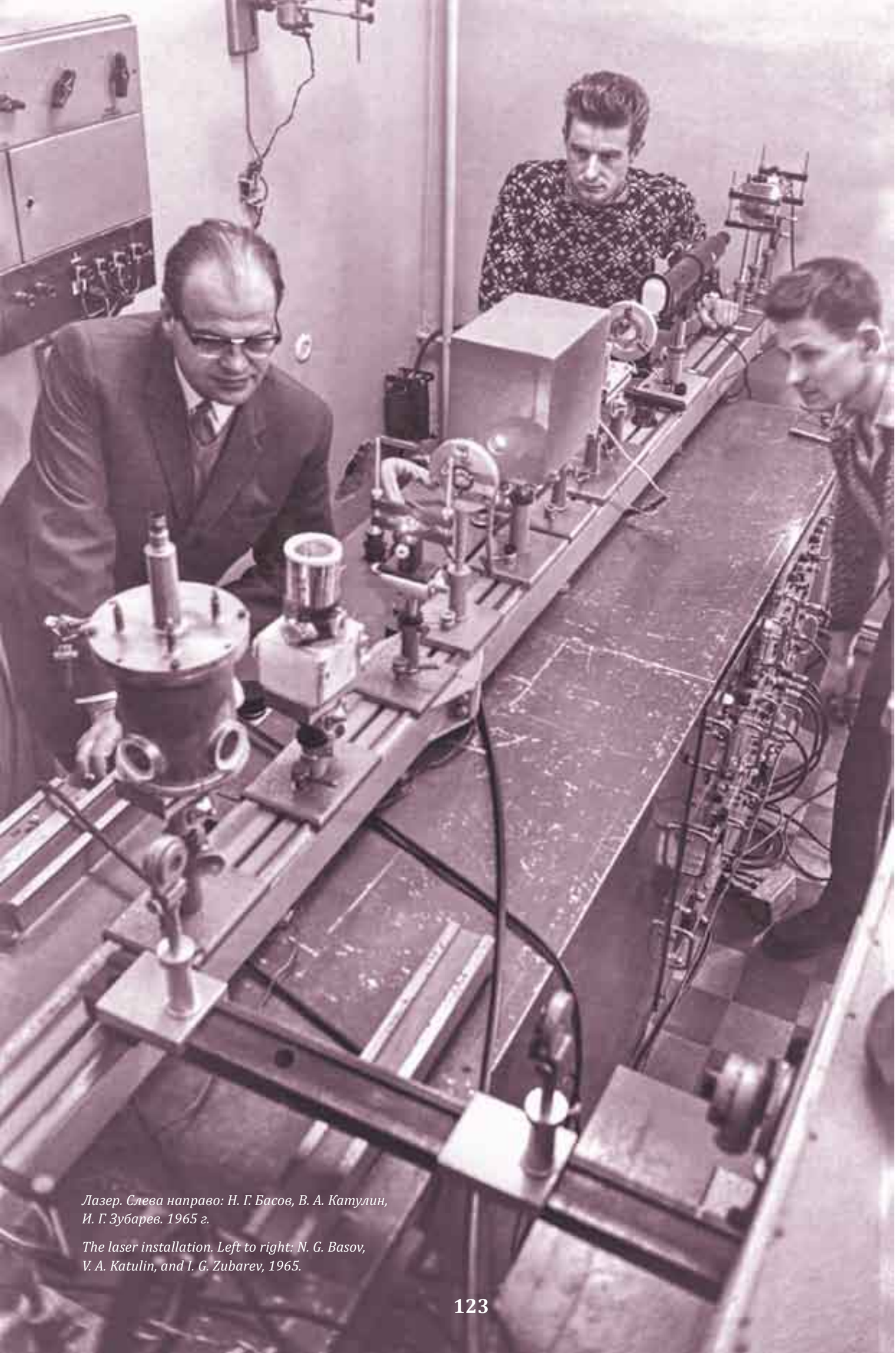
In 1966, Basov with co-workers (I. I. Sobelman, A. Z. Grasyuk, I. G. Zubarev) proposed to use the stimulated Raman and the so-called Mandelstam-Brillouin scattering process for the converting.

Experiments performed made it possible to significantly increase the energy density of laser radiation and its brightness by several orders of magnitude. Currently, this method is also used to obtain coherent radiation in new spectral ranges. *(A. N. Oraevsky)*

PHASE CONGUGATION OF LASER RADIATION

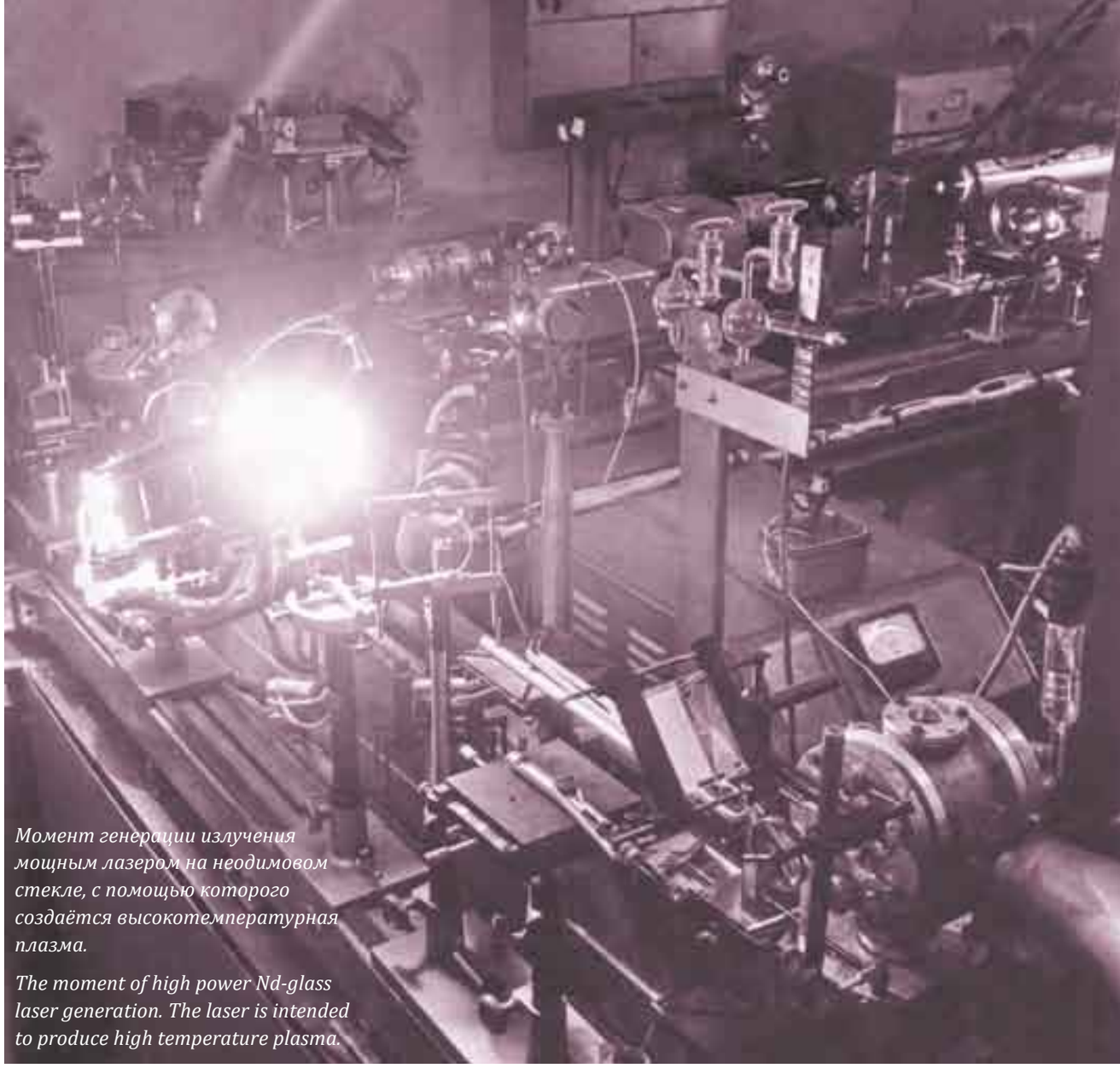
Development of researches on stimulated scattering by N. G. Basov's team led in 1971 to the experimental discovery of the phenomenon of laser radiation phase conjugation (B. Ya. Zel'dovich, V. V. Ragulsky, F. S. Faizullov). The phase conjugated wave has a unique property: when it moves back in the opposite direction, it accurately reproduces the wavefront at each point of its cross-section. This property allows one to use phase conjugation for compensating phase distortions of laser beams.

Passing through the laser amplifier, the laser beam gains energy, but its wavefront is deteriorated due to optical inhomogeneity of the amplifying medium. If, at the output of the amplifier, the amplified wave is phase conjugated and reflected back in the opposite direction, then during the reverse passage through the amplifier, the wave both gets additional energy and all its phase distortions acquired by the wave during the forward passage are compensated. As a result of the forward and backward passages, the radiation leaves the amplifier having its original quality of wavefront free from distortion due to imperfections of the amplifier medium. *(A. N. Oraevsky)*



Лазер. Слева направо: Н. Г. Басов, В. А. Катулин, И. Г. Зубарев. 1965 г.

The laser installation. Left to right: N. G. Basov, V. A. Katulin, and I. G. Zubarev, 1965.



Момент генерации излучения мощным лазером на неодимовом стекле, с помощью которого создаётся высокотемпературная плазма.

The moment of high power Nd-glass laser generation. The laser is intended to produce high temperature plasma.

SOLID STATE DISK LASER

The genius of academician N. G. Basov is involved in the development of a solid-state laser – a disk one, as well. True, this idea of his is already 55 years old, but it is precisely the «Basov» principle of constructing high-power laser systems that turns out to be dominant at present and for a long time in future. With the similar very favorable weight factor as for the fiber one, nowadays this design principle allows the implementation of high-energy high-repetition rate repetitively-pulsed mode.

<…> It is not possible to combine the power of more than 100 modules into a single beam in the case of the mobile complex. The ideas of academician Basov are still working today, since only the development of a single disk of large diameter makes possible further scaling of the output power of such a laser at present.

It is just this way of implementing high-energy disk lasers that we are developing today due to Nikolai Basov- the true author of the idea of disk geometry of the laser active body. *(V. V. Apollonov)*

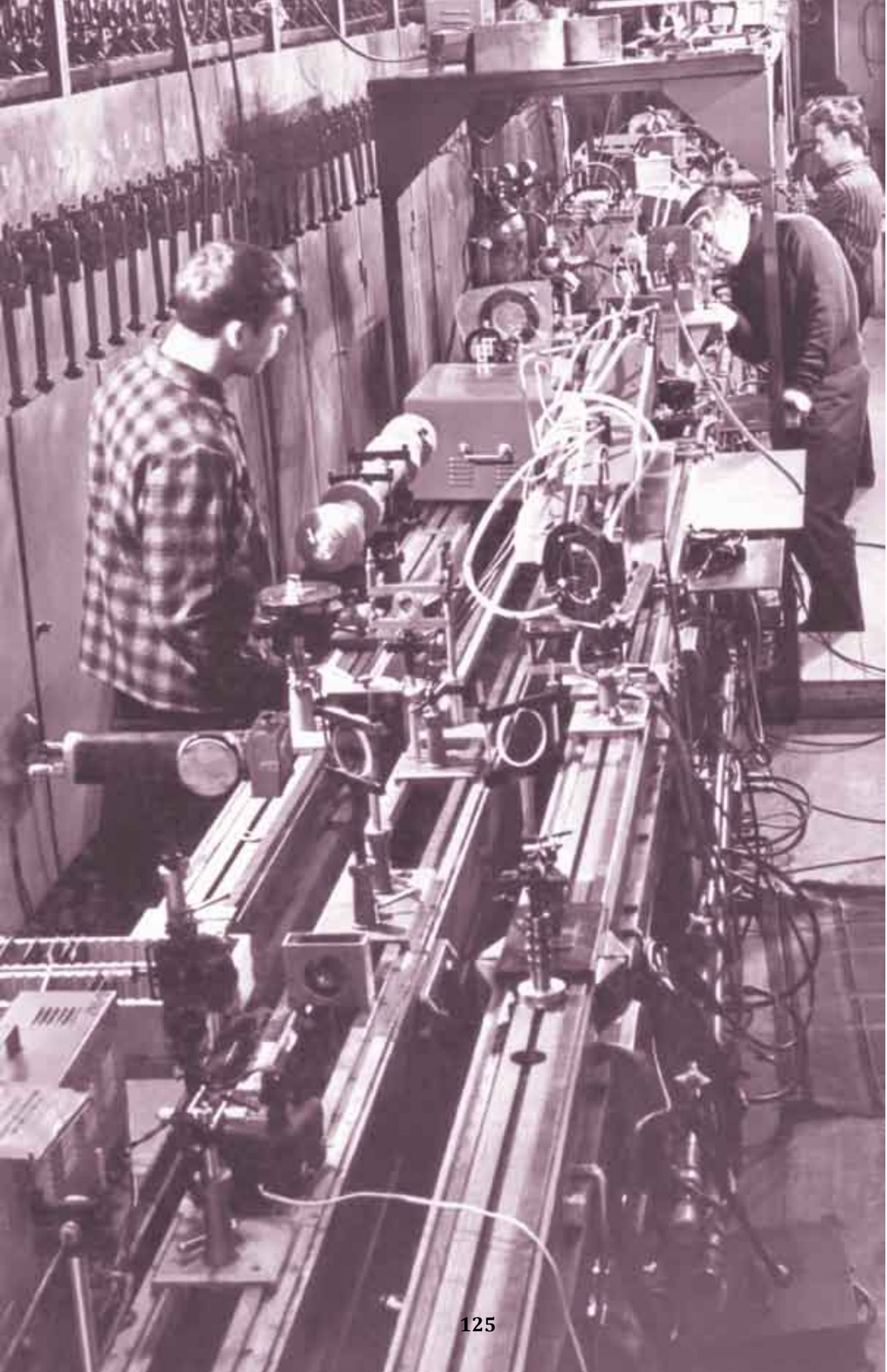
NEODIMIUM GLASS LASERS

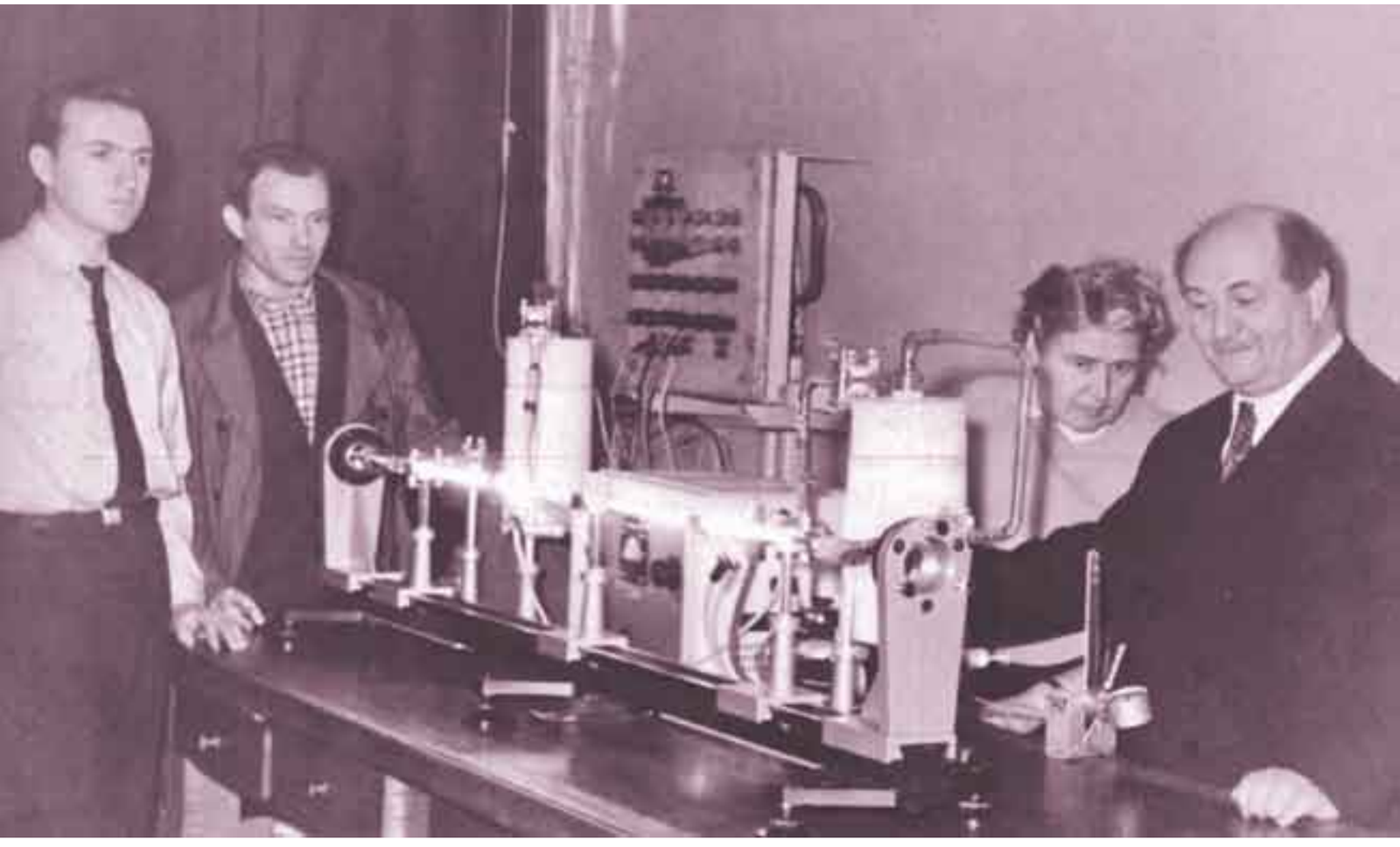
In the 1960s, along with crystal lasers, phosphate and silicate glass lasers became widespread. Quartz glass fiber optics gained particular importance.

For work on optical quantum generators based on neodymium glass and for mastering their serial production in 1974 the group of Soviet scientists and engineers – M. P. Vanyukov, A. A. Mak, A. M. Bonch-Bruevich, G. O. Karapetyan, E. I. Galant, E. M. Dianov, P. G. Kryukov, Yu. V. Lyubavsky, E. A. Vershinsky, E. M. Koryagin, B. N. Repin, B. V. Skvortsov – was awarded the State Prize. *(A. N. Oraevsky)*

Установка с мощным усилителем излучения лазера на рубине. ▶

Installation with a high power ruby laser amplifier.





Запуск первого в СССР HeNe лазера.
Д. Ш. Маш (справа) с сотрудниками.

Launching of the first in the USSR He-Ne laser.
Dr. D. S. Mash (right) with coworkers

STIMULATION OF CHEMICAL REACTIONS BY LASER RADIATION

N. G. Basov and his team performed the first experiments on the initiation of chemical reactions by infrared laser radiation. During those experiments, a non-thermal (photochemical) effect of IR laser radiation of moderate intensity was found, when the rate of resonant excitation of molecules was less than the decay rate of the exited level.

An explanation for this phenomenon was found on the basis of the parametric interaction of vibrations in complex molecules.

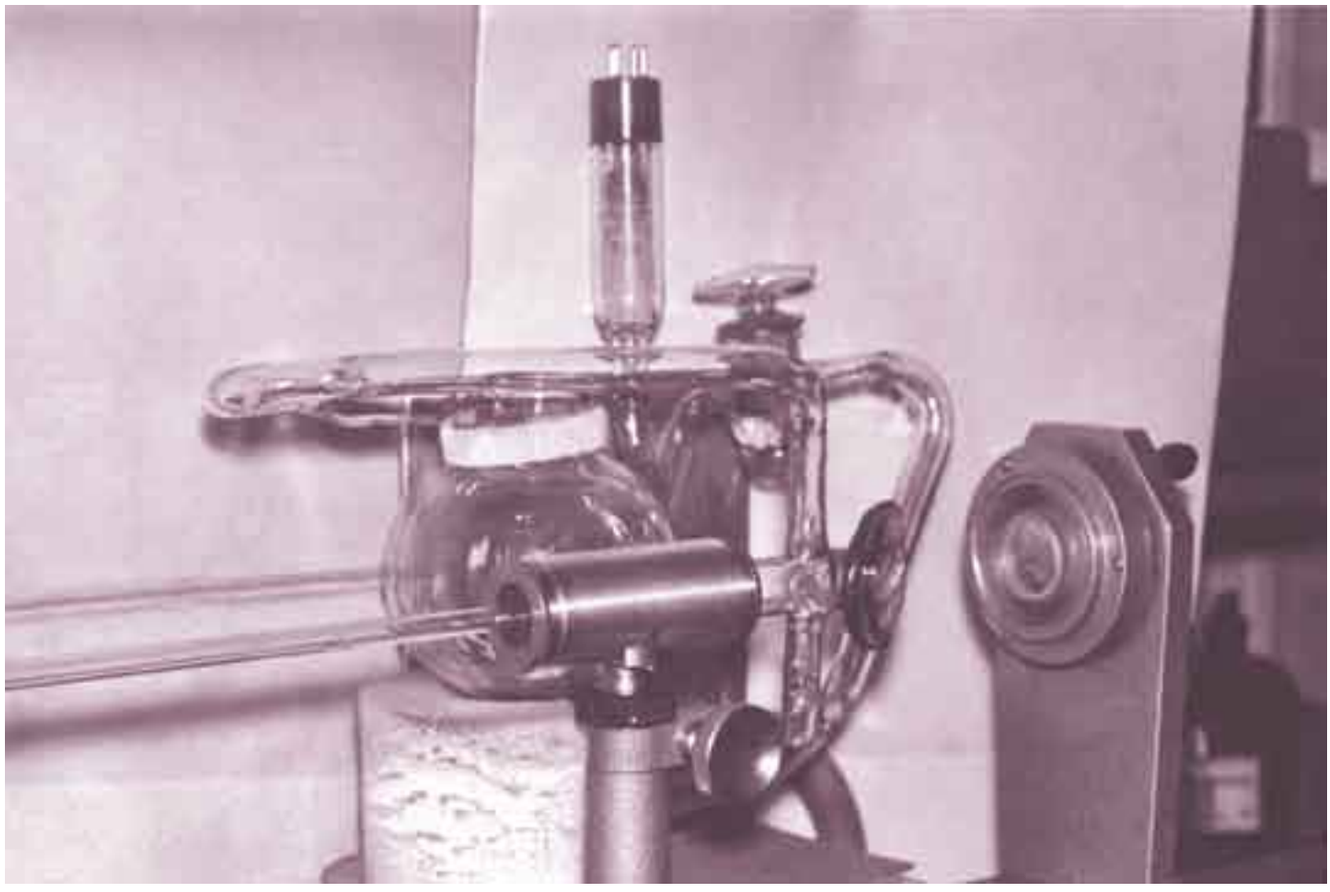
Isotopically selective chemical reactions of inert nitrogen with oxygen, initiated by the excitation of nitrogen molecules by stimulated Raman scattering and electric discharge at low temperatures, were experimentally observed.

One of the most attractive ideas for using laser radiation to initiate chemical reactions is to force them go along the allocated chemical bond.

The difficulty in realization of this idea is that with sufficiently strong excitation of the molecule the energy of the absorbed laser radiation is rapidly distributed among many vibrational degrees of freedom of atoms in molecules, which leads to the weakest bond dissociation of the molecule.

N. G. Basov's collaborators succeeded in carrying out the destruction of polyatomic molecules, selective in the vibrational degree of freedom (i. e., in the isolated bond), by the simultaneous action of infrared and ultra-violet laser pulses. *(A. N. Oraevsky)*

First pages of N. G. Basov' et al papers on stimulated VUV and laser compression of microspheres with deuterium. ▶



Инфракрасный HeNe лазер.

IR HeNe-laser.

Научные работы, написанные в соавторстве с Н. Г. Басовым.

Scientific papers of N. G. Basov and coauthors.

УДК 621.378.325

Н. Г. Басов, В. А. Даниличев, Ю. М. Попов

ВЫНУЖДЕННОЕ ИЗЛУЧЕНИЕ В ОБЛАСТИ ВАКУУМНОГО УЛЬТРАФИОЛЕТА

Обсуждена возможность достижения генерации в вакуумной области спектра при возбуждении конденсированных благородных газов электронным пучком. Экспериментально получена генерация на линии излучения на длине волны 1760 Å при возбуждении пучком электронов с энергией 800 кэв. Определена пороговая плотность тока (85—50 а/см²), измерена направленность излучения (~1°) и поляризация спектра генерации (~20 Å).

Создание генераторов все более коротких длин волн — одно из основных направлений развития исследований в области квантовой электроники. Ввиду того, что природа индуцированного излучения в этой области спектра принципиально не отличается от видимого диапазона, имеется довольно большое число работ, носящих характер предложений о создании коротковолновых генераторов, работающих даже в рентгеновском и γ-диапазонах, и начавших появляться вскоре после создания первых оптических квантовых генераторов. Экспериментально, однако, за прошедшие 10 лет удалось продвинуться только до λ=2358 Å [1] (переход в четырехкратно ионизованном неоне) и 2120 Å [2] (пятая гармоника неодимового лазера).

Основная трудность получения генерации в коротковолновой части спектра заключена как в отсутствии селективных и достаточно эффективных источников накачки на высокие энергетические уровни, так и в распаде в большое число радиационных осцилляторов, которое растет пропорционально квадрату частоты и приводит к уменьшению радиационного времени жизни, а также в широких полосах излучения и быстрых релаксациях возбужденных состояний. Вследствие этих обстоятельств основные надежды на продвижение в более коротковолновую область при использовании газов связываются с мощными, очень короткими (порядка наносекунд) импульсными разрядами, как это имеет место для лазеров на молекулах азота [3]. В этом случае, однако, происходит возбуждение большого числа уровней, не принимающих участия в интересующей нас генерации, и поэтому трудно ожидать высокой эффективности таких лазеров. Имеются и другие возможности полу-

Письма в ЖЭТФ, том 26, вып. 8, стр. 551 — 555 *20 октября 1977 г.*

НАБЛЮДЕНИЕ СЖАТИЯ ГАЗОНАПОЛНЕННЫХ МИКРОСФЕР, ОБЛУЧАЕМЫХ ЛАЗЕРОМ

Н.Г.Басов, А.А.Ерохин, В.А.Жаринов, Н.Н.Зорев, А.А.Кологривов, О.Н.Крохин, А.А.Рупасов, Г.В.Склизков, А.С.Шиканов

Приводятся результаты экспериментальных исследований взаимодействия излучения двухлучевой лазерной установки "Кальмар" со сферическими оболочками из SiO_2, наполненными дейтерием. С помощью камер обскур зарегистрировано тысячекратное сжатие мишени.

В отличие от экспериментов по сжатию оболочечных мишеней, выполненных при плотностях потока $q \sim 10^{13} \div 10^{14}$ *вт/см²* и длительности импульса $\sim 10^{-10}$ *сек* [1, 2], в данной работе, как и в [3], длительность импульса (~ 1 *нсек*) была сравнима с временем сжатия оболочек. Как показано в [4], такой режим сжатия приводит к большим конечным плотностям газа.

Излучение лазерной установки "Кальмар" фокусировалось с зенитного сектора на оболочечную мишень из стекла SiO_2 ($2R \sim 70 \div 140$ *мкм*). При диаметре световых пучков в области мишени ~ 150 *мкм* и энергии $E_{пад} \sim 60 \div 100$ *дж* плотность потока составляла $q \sim 10^{14}$ *вт/см²* [5]. Лазерный импульс имел длительность ~ 1 *нсек* по полуширине интенсивности при длительности переднего фронта $\sim 0{,}5$ *нсек*.

На рис. 1,*а* представлена обскурограмма плазмы и собственного рентгеновского ($h\nu \gtrsim 2$ *кэв*) излучения. Оболочка с $2R = 140$ *мкм*, $\Delta R = 2{,}2$ *мкм* была наполнена дейтерием под давлением ≈ 35 *атм*. Отчетливо видны два концентрических светящихся кольца. Внешнее соответствует разлетающейся короне мишени, а внутреннее — слою стекла, прилегающего к находящемуся внутри мишени сжатому D_2 — газу. Отсюда можно определить его объемное сжатие δ. Величина δ, как правило, возрастает с увеличением диаметра мишени и при $2R \sim 120 \div 140$ *мкм* и $\Delta R \sim 2 \div 3$ *мкм* составляет $\sim 10^2$, как, например, в случае, приведенном на рис. 1,*а*. Плотность сжатого дейтерия в этом случае достигает $6 \div 8$ *г/см³*, а значение параметра $\rho R = 10^{-2}$ *г/см²*.

Во время пребывания делегации АН СССР в ГДР. Декабрь 1965 г.

A delegation from the USSR Academy of Sciences visits German Democratic Republic (GDR), December 1965.

Слева направо: второй – В. Л. Макаров, Н. Г. Басов, М. В. Келдыш. Италия. 1969 г.

Left to right: V. L. Makarov (second), N. G. Basov, M. V. Keldysh, Italy. 1969.

N. G. Basov is one of the outstanding Soviet physicists. His name is associated with the emergence of a new field of science – quantum electronics.

N. G. Basov is a representative of the generation of scientists whose creative activity belongs to the post-war period, when the rapid pace of scientific and technological progress attracted to science, especially natural science, a lot of talented young people.

If now we can say that Soviet science is at the forefront of world science, then to a large extent this is the success of the young post-war generation of scientists developing the rich traditions of Russian scientific schools. *(D. V. Skobeltsyn)*

Во время пребывания делегации АН СССР в ГДР. Декабрь 1965 г.

A delegation from the USSR Academy of Sciences visits German Democratic Republic (GDR), December 1965.

Главы дипломатических представительств, аккредитованные в СССР, посетили ФИАН. Дипломатам были показаны лаборатории института. 28 ноября 1969 г.

Heads of diplomatic missions accredited to the USSR visited the Lebedev Institute. The diplomats were shown the laboratories of the Institute. November 28, 1969.

HIGH IMPLEMENTATION RATIO

I would like to note one feature of Nikolai Gennadievich – a unique logic of thinking, which, as it seems to me, did not develop along the simplest path – from the foundations of physics, presented in textbooks, to some more complex constructions. Nikolai Gennadievich followed the opposite path – from the final result.

There is a well-known story told by my colleagues who worked with Nikolai Gennadievich in the mid-1950s. I heard a few words about it from him too. This story is related to the question of the width of the maser spectral line.

Nikolai Gennadievich believed that in the case of induced amplification due to regeneration in the resonator the linewidth can be narrower than the natural width of the transition line. The logic of his reasoning was simple – after all, a maser is a self-oscillatory system.

They say that L. D. Landau, whom Nikolai Gennadievich went to consult to, initially rejected such a possibility, since it would contradict the uncertainty principle. However, later this phenomenon found a natural explanation with the use of the principle of indistinguishability of molecules entering the resonator and leaving it in a certain quantum state. Apparently, Nikolai Gennadievich was inherent in building his own model of the phenomenon, and his vision was often different from that of his colleagues, and probably more complex.

Perhaps it was due to the fact that when discussing a particular issue, it was sometimes difficult for us, his students, to immediately understand Nikolai Gennadievich, since he most likely believed that the listeners mentally had already passed the part of the path he himself had passed.

I am convinced that it was precisely this professional quality of Nikolai Gennadievich that became the main underlying condition for the emergence of unusually bright ideas, so characteristic of his creative biography. It is believed that if at least one out of 10 ideas or proposals is implemented, this is already a big success. N. G. Basov's implementation ratio was much higher. *(O. N. Krokhin)*

Н.Г.Басов, С.Д.Захаров, П.Г.Крюков
Ю.В.Сенатский, С.В.Чекалин

ЭКСПЕРИМЕНТЫ ПО НАБЛЮДЕНИЮ НЕЙТРОНОВ ПРИ ВОЗДЕЙСТВИИ МОЩНОГО ЛАЗЕРНОГО ИЗЛУЧЕНИЯ, СФОКУСИРОВАННОГО НА ПОВЕРХНОСТЬ ДЕЙТЕРИДА ЛИТИЯ

Доклад, представленный на У Международную конференцию по квантовой электронике
Майами, США

Москва–1968г.

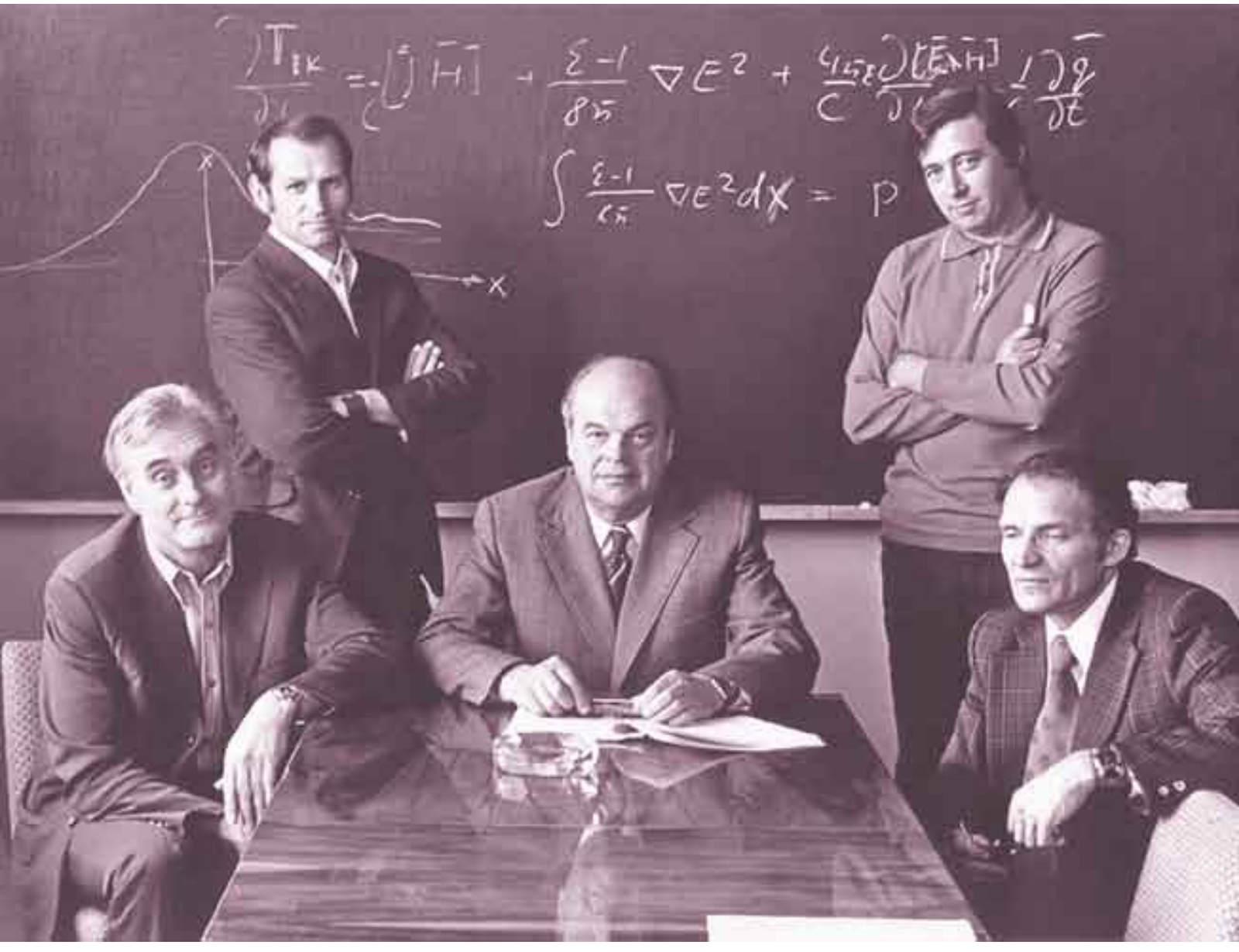
ЭКСПЕРИМЕНТЫ ПО НАБЛЮДЕНИЮ НЕЙТРОНОВ ПРИ ФОКУСИРОВКЕ МОЩНОГО ЛАЗЕРНОГО ИЗЛУЧЕНИЯ НА ПОВЕРХНОСТЬ ДЕЙТЕРИДА ЛИТИЯ

Н.Г.Басов, С.Д.Захаров, П.Г.Крюков, Ю.В.Сенатский, С.В.Чекалин

В настоящей работе сообщаются результаты предварительных исследований, направленных на получение термоядерных температур в плотной плазме с помощью мощного лазерного излучения.

В 1962 году было показано [1], что при фокусировке мощного лазерного излучения на поверхность твердой мишени, содержащей дейтерий, можно получить плотную плазму с температурой, достаточной для протекания термоядерных реакций.

Рис. 1. Схема опыта по наблюдению нейтронов



О. Н. Крохин, Е. Г. Гамалий, Н. Г. Басов, Ю. В. Афанасьев, В. Б. Розанов. 1967 г.

O. N. Krokhin, E. G. Gamaly, N. G. Basov, Yu. V. Afanasiev, and V. B. Rozanov, 1967.

OUT OF THIN AIR RESULTS

Despite the high-intensity pace of life, Nikolai Gennadievich continued to set new tasks and solved them successfully: discoveries followed one after another. The intuitive mindset helped him with it.

His employees would say that Nikolai Gennadievich took the results as if out of thin air, without complex mathematical calculations. Some of N. G.'s ideas seemed «crazy» at first glance, but then they were often turned to life. So, it was with the coherence of laser radiation, for example: it was, as he wrote down somewhere, just an obsession, it contradicted, at first glance, the uncertainty principle. But it turned out that this contradiction was successfully resolved – now everyone knows it. The collegues called Nikolai Gennadievich a generator of ideas, and he, in turn, was very proud of them and rejoiced in their success. *(K. T. Basova)*

Ю. М. Попов, В. С. Зуев, Д. В. Ковалевский, О. Н. Крохин, Н. Г. Басов. 1967 г.

Yu. M. Popov, V. S. Zuev, D. V. Kovalevsky, O. N. Krokhin, and N. G. Basov, 1967.

LASER RACE

In the early 1960s, when the idea of a laser – a generator of a powerful coherent highly directional light beam – began to overgrow with the «iron» *(slang for technical equipment – ed. remark)* of technical solutions in physics laboratories, there appeared real opportunities for developing optical quantum generators with high power and radiation energy. Many scientists and military men in the United States and soon in the USSR got the idea about the possibility of creating a weapon that would allow hitting the target with a «incinerating» beam.

Thousands of scientists at the largest laboratories in the USA, the USSR, European countries, Japan and China started working on the development of lasers. The gist of the main idea – amplification of the stimulated emission of a large number of particles, atoms and molecules placed in an optical cavity – turned to be very great. The main scientific center of our country, where pioneering work on quantum generators and, in particular, on lasers was carried out, was the P. N. Lebedev Physical Institute of the USSR Academy of Sciences *(FIAN – Russian acronym – ed. remark)*

In the early 1960s FIAN scientists, primarily groups led by A. M. Prokhorov and N. G. Basov, concentrated their efforts on increasing the energy and power of laser radiation, as well as on the search for new types of lasers. The Institute was dominated by an atmosphere of optimism and confidence in the possibility of achieving high energy characteristics of lasers. *(P. V. Zarubin)*

FOR ADVICE – TO THE ACADEMY OF SCIENCES

In 1963, Deputy Minister of Defense of the USSR A. A. Grechko addressed the President of the USSR Academy of Sciences M. V. Keldysh with the request to evaluate possibility of military applications of lasers. The latter, in turn, asked for the opinions of the leading laser physicists from FIAN including N. G. Basov.

In the response of the USSR Academy of Sciences, the great potential of lasers for both scientific and defense applications was emphasized and new areas of research on increase of the energy of lasers that existed at that time and development of new types of lasers were proposed. *(P. V. Zarubin)*

Д. Ф. Устинов, Л. И. Горшков, А. П. Александров, Б. Е. Львов, Н. Г. Басов.

D. F. Ustinov, L. I. Gorshkov, A. P. Alexandrov, B. E. L'vov, N. G. Basov.

SUPPORTED BY USTINOV

N. G. Basov was, of course, the enthusiast and driving force behind the high-power lasers project.

In 1964–1965, it became possible to convince the military-industrial leadership of the country, first of all D. F. Ustinov, as well as a number of other state and military leaders, that this problem, in principle, could be solved.

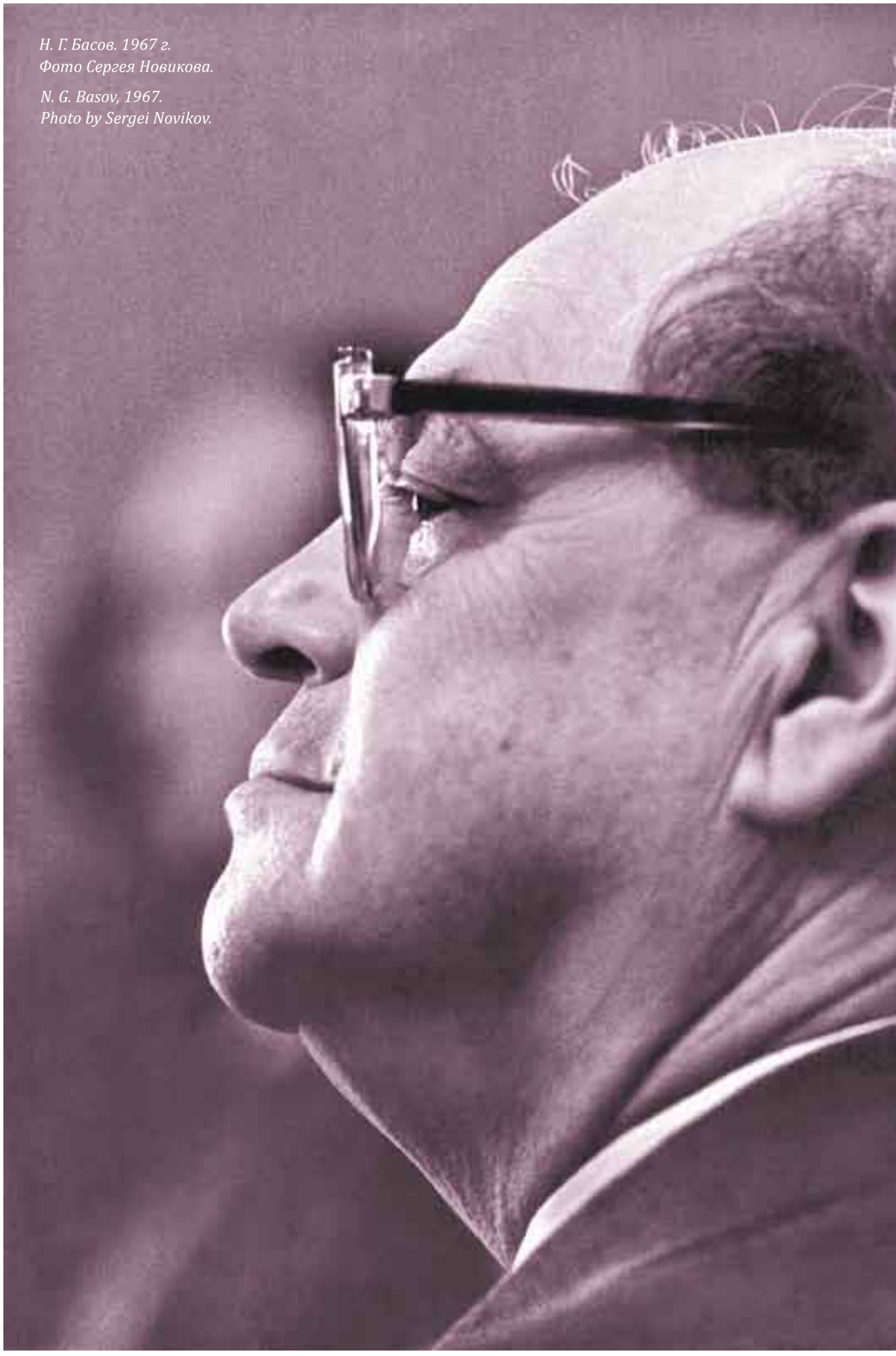
It must be said that D. F. Ustinov, being an engineer by education, deeply realized the decisive role of science in the development of military equipment, was accessible to prominent scientists and designers, and supported with interest the new projects that promised progress in military equipment development. *(P. V. Zarubin)*

WE ARE WORKING ON ... NEW TYPES OF LASERS

And here I can tell about some other methods of pumping, which had been used for lasers. Those were the thermal pumping technique, from which gas dynamic lasers emerged, and the combined pumping which included an electron beam previously used in semiconductors, and the electric discharge technique. In 1970 a special type of a non-selfsustained high-current discharge was discovered; it was obtained for the first time by V. A. Danilychev. Thus, so called electroionization lasers appeared. In USA similar lasers were devised at Los Alamos in Prof. K. Boyer's group and at AVCO by Profs. Kantrowitz, Daugherty and coworkers in 1971. In 1966 we started investigations in the vacuum ultraviolet which resulted in the appearance of the first excimer laser on xenon in 1970 (N. G. Basov, V. A. Danilychev, Yu. M. Popov). We continue now these investigations. Today we have quite a number of new types of lasers, new materials, and new methods of excitation. We are working on new proposals concerning the methods of excitation, new materials and new types of lasers.

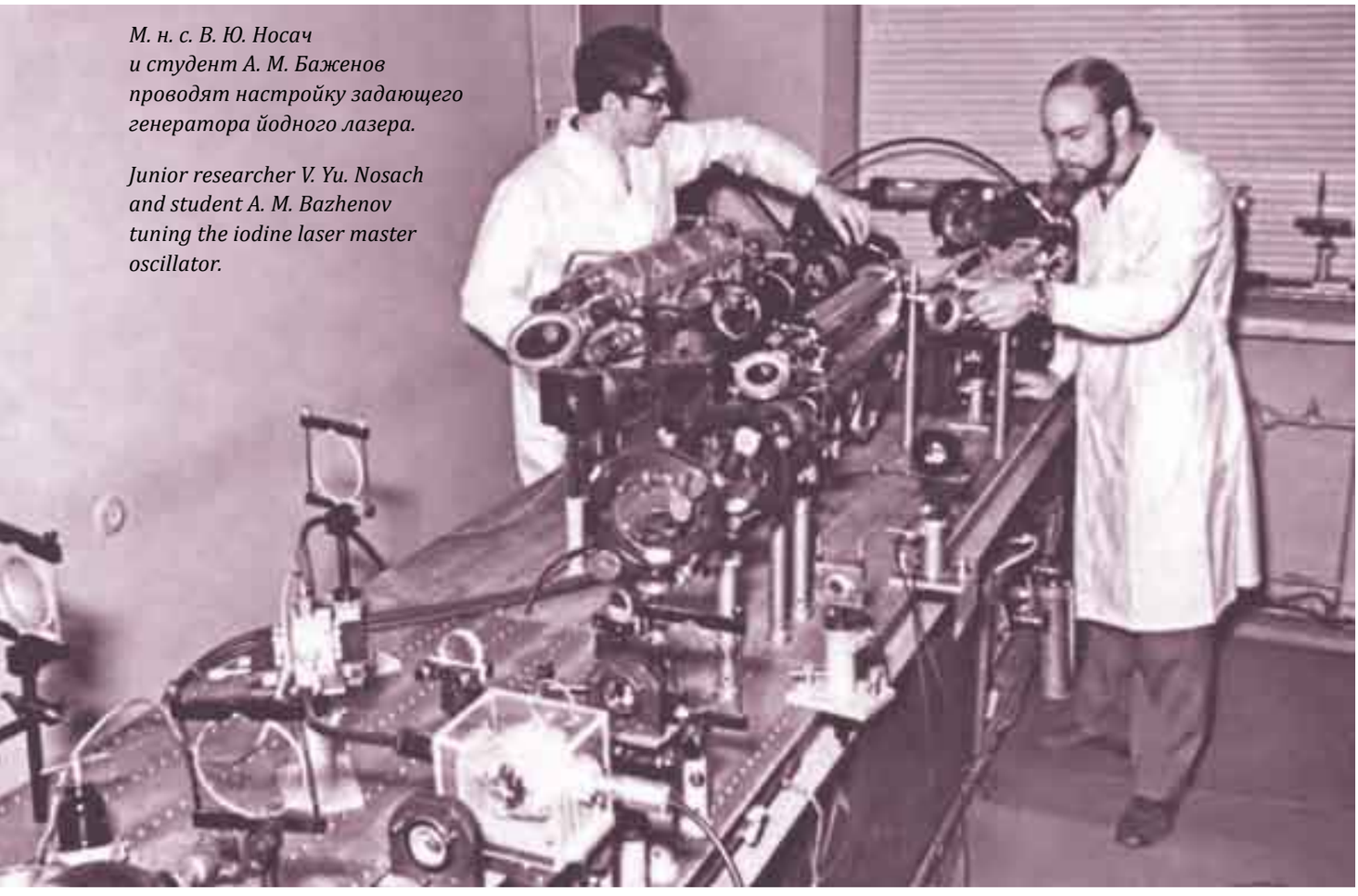
Much work has been done on improving the coherence of lasers by means of the stimulated scattering. We succeeded in increasing, by about three to four orders, the radiation coherency for Nd-lasers, ruby lasers, and lasers on molecular dissociation. Drs. A. Z. Grasiuk and I. G. Zubarev were actively engaged in this work. There has been achieved a considerable narrowing of the line, reduction of the beam divergence; the radiation brightness was increased by four to five orders. This work is being continued. We have devised various types of lasers to be used in laser fusion investigations. For the fusion experiments it is necessary to focus the radiation from the distance of hundred meters, into a minimal spot, where a very good radiative coherence is required. Various experimental techniques were tried for that. One can use lasers as pumping sources, and increase considerably the coherence by the stimulated Raman scattering, or the stimulated Mandelshtam-Brillouin scattering (SMBS) technique. We work actively with lasers based on stimulated scattering. There was some other problem on the way. The SMBS photons are propagating in the direction opposite to that in which the photons enter nonlinear medium. With what accuracy does it happen? The investigation of this problem resulted in the discovery of the phase conjugation phenomenon. Together with some other colleagues, Dr. F. S. Faizullov was awarded USSR State Prize for the discovery of this effect, which is also one of the means for increasing the radiation coherence. So, for example, we have lasers with the beam diameter of 4 cm, lenses of low quality and focal length of a few meters, and they focus the radiation onto the area of about 50 μm, i.e. using some intrinsic effects, we obtain the ultimate diffraction divergence and the ultimate coherence. This works has not yet been completed, it has many other trends. We try to use the phase conjugation in the far IR region for long pulses, for supershort pulses. Later on, numerous investigations were carried out at FIAN on the improvement of laser parameters, the search for new laser materials, or different methods of pumping. Here I'd like to mention that about two thirds of the number of all working lasers originated, in one way or another, from the Lebedev Physical Institute. They are excimer lasers, electroionization lasers, various types of semiconductor lasers; all of them have been proposed by us for the first time.

Then goes a three-level pumping, the thermal pumping, including gasdynamic lasers, the application of stimulated scattering for increasing the radiation coherence; the discovery of the phase conjugation method and its usage for increasing of the spatial coherence; the photodissociation lasers which were actively developed, viz. by V. S. Zuev (the photodissociation laser was first proposed also in FIAN By S. G. Rautian and I. I. Sobelman), etc. One should also mention the chemical laser, where many various methods for pulsed and CW chemical lasers were proposed. For chemical lasers a group of our colleagues was awarded this year the Lenin Prize, which is the supreme award for scientists in this country. A. N. Oraevsky is one of the laureates of this prize. For semiconductor lasers two Lenin Prizes were awarded, and at present the USSR State Prize is proposed for the semiconductor lasers on quaternary compounds, in which the priority belongs to the Soviet scientists. I wouldn't discuss in detail the question of priority here, since many scientists work in our field of research, but the contribution of soviet scientists is quite significant. All this is the result of systematic work of many laboratories of FIAN. Results of the first stage of this work are contained in the Institute's report of December, 1961. In that report almost all types of lasers were mentioned: Raman lasers, photodissociation lasers, a great number of new crystals, semiconductor lasers. The research program was fulfilled in the course of three-four years, since 1958, when the wide-scale laser investigations had been started in the Soviet Union. The report contains many interesting results. (*N. G. Basov*)



Н. Г. Басов. 1967 г.
Фото Сергея Новикова.

N. G. Basov, 1967.
Photo by Sergei Novikov.

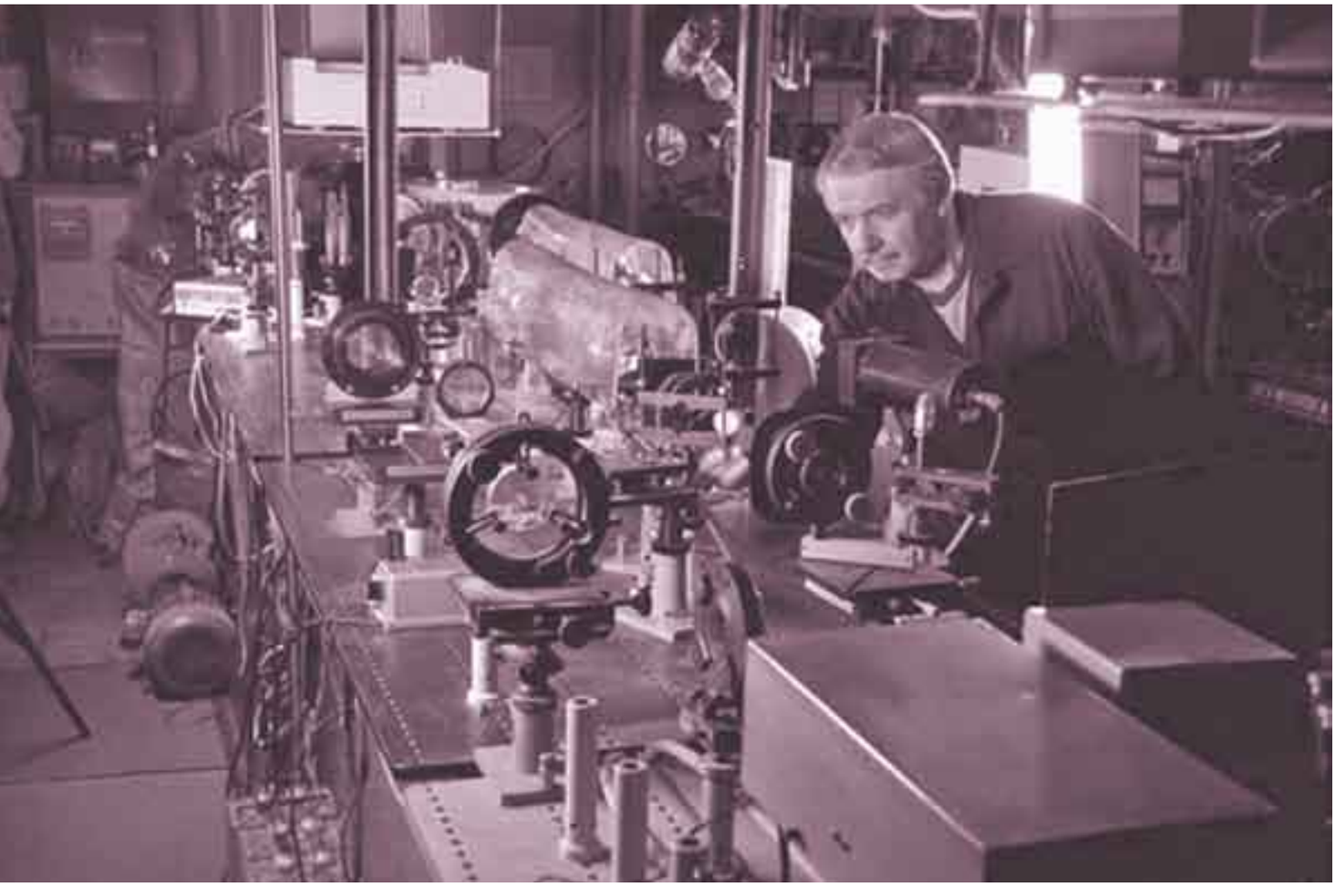


М. н. с. В. Ю. Носач и студент А. М. Баженов проводят настройку задающего генератора йодного лазера.

Junior researcher V. Yu. Nosach and student A. M. Bazhenov tuning the iodine laser master oscillator.

Активный квантовый фильтр. Исследование проводит О. Ю. Носач.

An active quantum filter. Investigation is performed by O. N. Nosach.



PHOTODISSOCIATION LASERS FOR THE MISSILE DEFENSE SYSTEM

The development of photodissociation lasers (PDL) played a special role in the work for missile defense aims. The physical idea underlying the PDL was proposed by FIAN scientists S. G. Rautian and I. I. Sobelman in 1961.

N. G. Basov and O. N. Krokhin suggested using this type of laser to achieve extremely high energy characteristics when it is optically pumped by radiation from high-temperature explosive sources – powerful light radiation of a shock wave in a heavy gas created by the explosive charge explosion.

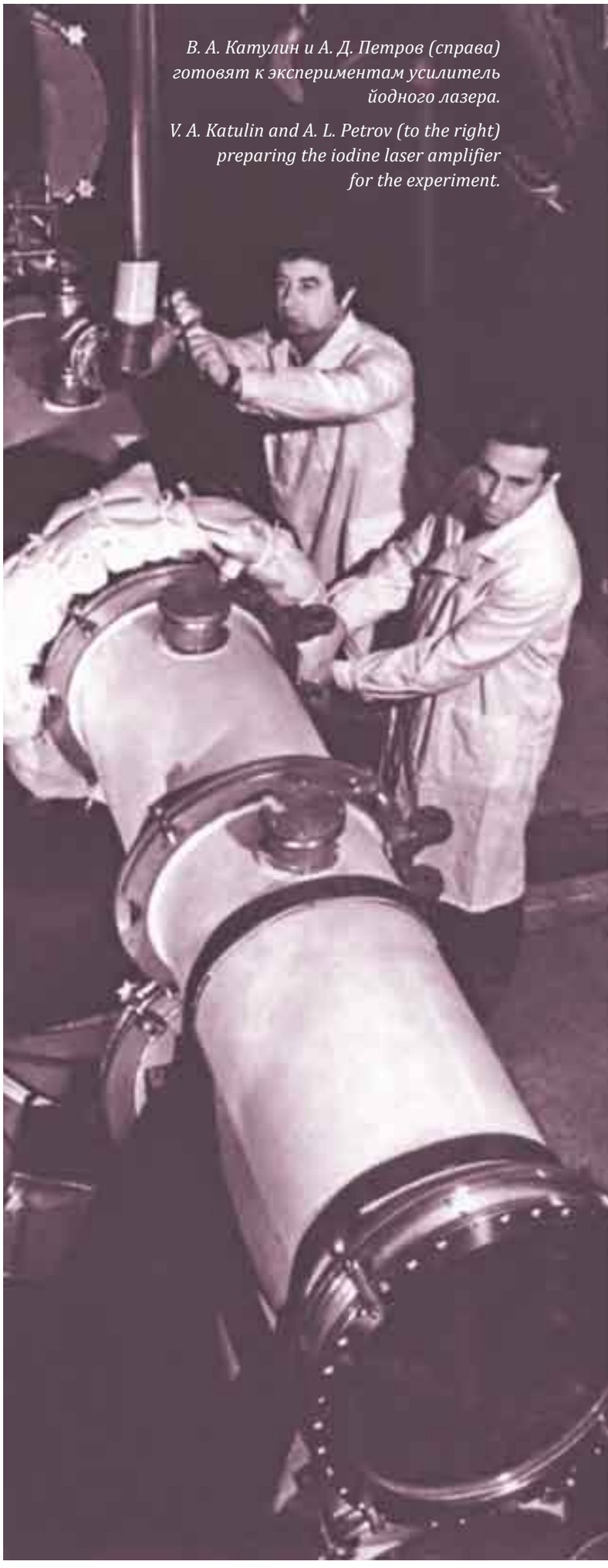
PHOTOCHEMICAL LASERS

A special place in the work of N. G. Basov and his staff is occupied by studies of photochemical lasers pumped by radiation from a strong shock wave. The shock wave propagates in the working substance of the laser. Those works were carried out under the scientific supervision of N. G. Basov by the teams of two organizations – the Physical Institute of the Academy of Sciences (FIAN) (V. S. Zuev and his group) and the All-Union Institute of Experimental Physics *(Russian acronym is VNIIEF – ed.remark)* with the involvement of wider collaboration between branch research institutes and industry later.

The result of that work was the development of explosive-type iodine photodissociation lasers, capable of generating high-power laser pulses, currently considered as drivers that trigger the reaction of laser thermonuclear fusion. Within the framework of this concept, the explosive amplifier of short pulses with the energy of 6 kJ in a single laser beam was created at VNIIEF. The work on lasers with explosive pumping was awarded the State Prize of the USSR.

In 1976, the iodine photodissociation laser emitting up to 300 J per pulse of nanosecond duration was built at the FIAN. The laser was pumped by radiation from a powerful electric discharge. An unusual solution of the pumping problem was that the discharge was formed in the working medium of the laser itself. The results obtained served as the basis for the development and creation at VNIIEF of a high-power Iskra laser facility that generated a pulse with the energy of 30 kJ per a quarter of nanosecond.

At present, it is one of the three or four largest installations in the world designed for research in the field of laser thermonuclear fusion. *(A. N. Oraevsky)*



В. А. Катулин и А. Д. Петров (справа) готовят к экспериментам усилитель йодного лазера.

V. A. Katulin and A. L. Petrov (to the right) preparing the iodine laser amplifier for the experiment.

COLLABORATION
FOR HIGH-POWER LOCATOR

In 1962, theoreticians and experimenters of the Vympel Design Bureau, where N. D. Ustinov headed the laser laboratory, began to analyze laser location systems and evaluate their capabilities arising from the properties of laser radiation. Scientific achievements of FIAN Basov's group in particular, were the main driving force. Work on the use of lasers at «Vympel» Design Bureau was being carried out in constant contact with N. G. Basov and his staff and to a large extent on their initiative.

That collaboration had been born even earlier, in the course of work on the use of masers as low-noise amplifiers of weak signals in the receiving paths of missile defense system radars.

At the beginning of 1963, as a result of the research carried out at the Vympel Design Bureau, which relied on the work and forecasts on lasers of N. G. Basov's group, a project for the design of an experimental laser radar for missile defense, which received the code name LE-1, was submitted to the Military-Industrial Commission (MIC, the body of state administration of the military-industrial complex of the USSR).

The project was based on the work of FIAN on research and development of ruby lasers.

The decision to create the high-precision experimental locator LE-1 for determining the HPBM *(Head-Part of a Ballistic Missile – ed. remark)* coordinates at distances up to 400 km at the Balkhash anti-missile test site was approved in September 1963. Scientific management of the work on the development of lasers for LE-1 was entrusted to the Lebedev Physical Institute (the laboratory of N. G. Basov). Lots of difficulties arose in the course of work. By 1966, when it became clear that the development of LE-1 would require the efforts of not only the scientists, but of the industry as well, primarily optical and electronic ones, it had become necessary to develop and master many new devices, technologies and materials in mass production: high-quality ruby crystals, electro-optical crystals for shutters that control the shape of a laser pulse, special pump lamps for lasers, highly sensitive photodetectors, and much more. All those factors led to the fact that the locator was built and began to function only in the mid-70's. *(P. V. Zarubin)*

В. С. Зуев, О. Н. Крохин, Н. Г. Басов, И. И. Собельман. 1967 г. *V. S. Zuev, O. N. Krokhin, N. G. Basov, and I. I. Sobel'man, 1967.*

The BIG Soviet HE lasers ideas

First scientific and engineering design ideas aimed at creating multimegawatt CW lasers and multimegajoule pulsed lasers were formulated by Soviet scientists and engineers in as early as in 1963 !

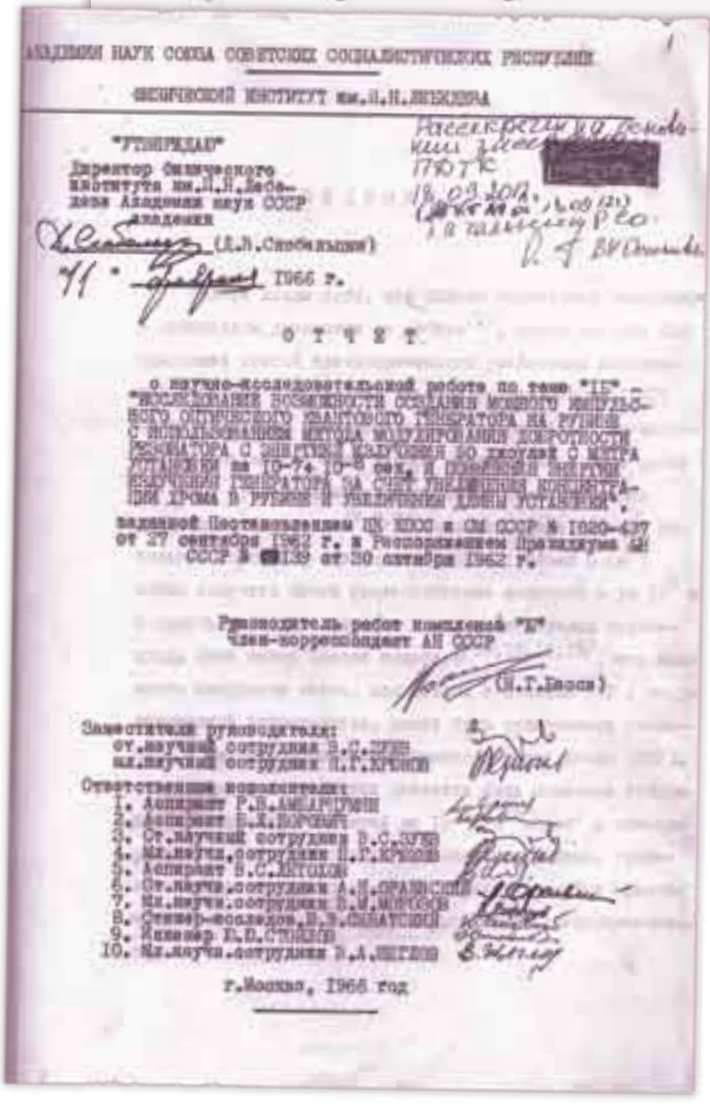
"Probably, it is possible to make generators with energy up to 10^6-10^7 J using an explosion of conventional HE as a power source..." (Basov meant laser generators). Lasers with 10^9 pulse energy were also mentioned – A-bomb radiation was suggested for pumping…

A declassified letter dated December 1963 signed by FIAN (Lebedev institute) deputy director N.Basov and initiated by O.Krokhin, addressed to the president of the Soviet Academy of science M.Keldysh in reply to an inquiry by the Soviet ministry of Defense.

N.Basov

O.Krokhin

Only 1…10-joule class pulsed lasers were available in 1963…



АКАДЕМИЯ НАУК СОЮЗА СОВЕТСКИХ СОЦИАЛИСТИЧЕСКИХ РЕСПУБЛИК

ФИЗИЧЕСКИЙ ИНСТИТУТ им.П.Н.ЛЕБЕДЕВА

"УТВЕРЖДАЮ"
Директор Физического института им.П.Н.Лебедева Академии наук СССР
академик
(Л.В.Скобельцын)
"11" февраля 1966 г.

О Т Ч Ё Т

о научно-исследовательской работе по теме "Е" – "Исследование возможности создания мощного импульсного оптического квантового генератора на рубине с использованием метода модулирования добротности резонатора с энергией излучения 50 Дж с метра установки за 10^{-7} + 10^{-8} сек и повышения энергии излучения генератора за счёт увеличения концентрации хрома в рубине и увеличения длины установки".

выданной Постановлением ЦК КПСС и СМ СССР № 1020-437 от 27 сентября 1962 г. и Распоряжением Президиума АН СССР № 1139 от 30 октября 1962 г.

Руководитель работ по теме "Е"
член-корреспондент АН СССР
(Н.Г.Басов)

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ст.научный сотрудник В.С.Зуев
мл.научный сотрудник П.Г.Крюков

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4. Мл.науч.сотрудник П.Г.Крюков
5. Аспирант В.С.Летохов
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7. Мл.науч.сотрудник В.М.Морозов
8. Стажер-исследов. В.В.Осипов
9. Инженер Е.Д.Стоилов
10. Мл.науч.сотрудник В.А.Шигорин

г.Москва, 1966 год

Отчёт о научно-исследовательской работе по теме: «Исследование возможностей создания мощного импульсного оптического квантового генератора на рубине с использованием метода модулирования добротности резонатора с энергией излучения 50 Дж с метра установки за 10^{-7} + 10^{-8} сек и повышения энергии излучения генератора за счёт увеличения концентрации хрома в рубине и увеличения длины установки». 11 февраля 1966 г.

Report on research work on the topic: «Studying a feasibility of designing a high-power pulsed optical quantum generator on ruby using a Q-switched resonator with the energy of 50 Joules per meter of the installation during 10^{-7}-10^{-8} sec, and heightening the radiation energy by means of increasing the chromium concentration in ruby, and by increasing the installation length, February 11, 1966.

The work under the program «Terra-3» made it possible to increase the energy and power of Photo Dissosiation Laser (PDL) radiation by millions of times within 4–5 years and to obtain, by 1970, such radiation energy, which is inaccessible in other lasers even now.

Since 1969, the Scientific and Technical Council (STC) under the leadership of N. G. Basov had become the think-tank of the program. The council included representatives of many research and design organizations, representatives of the Ministry of Defense and the Ministry of Defense Industry. In addition to STC meetings, weekly scientific and technical meetings at N. G. Basov's were held, where new ideas and projects were considered, ways to solve constantly emerging scientific and engineering problems were discussed. A program of scientific research on lasers (electroionization, chemical pulsed and CW ones, Raman lasers), on the study of the processes of the impact of laser radiation on materials and military equipment, on the propagation of laser radiation in the atmosphere, on linear and nonlinear optics of lasers and optical materials resistant to laser radiation was formed. *(V. P. Zarubin)*

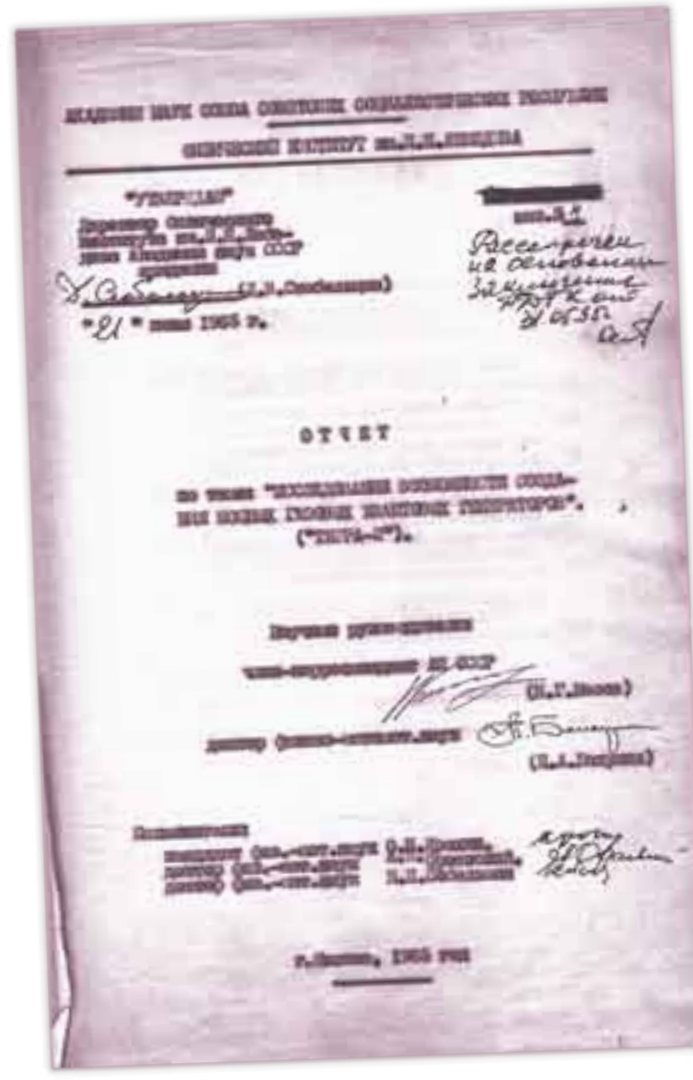
ФДЛ с энергией в импульсе 1 МДж (ВНИИЭФ).

Photodissociation laser, pulse energy 1 MJ, VNIIEF.

TERRA-3 PROGRAM

In the autumn of 1965, N. G. Basov, the scientific director of VNIIEF (Arzamas-16) Yu. B. Khariton, the deputy director of the GOI *(Russian acronym for the S. I. Vavilov State Optical Institute – ed.remark)* for scientific work E. N. Tsarevsky and the chief designer of the Vympel Design Bureau G. V. Kisunko sent a note to the Central Committee of the CPSU *(Communist Party of the Soviet Union – ed. remark)* about the fundamental possibility of hitting the HPBM with laser radiation and where it was proposed to deploy an appropriate experimental program.

The proposal was approved, and the program of work to create a laser firing system for missile defense tasks was approved by the government decision in 1966. The program received the code «Terra-3». *(V. P. Zarubin)*



ОТЗЫВ

Рассекреченный отчёт о возможности создания мощного оптического квантового генератора по программе «Терра-2». 1965 г.

Declassified report on a feasibility of designing a high-power optical quantum generator by the «Terra-2» programme, 1965.

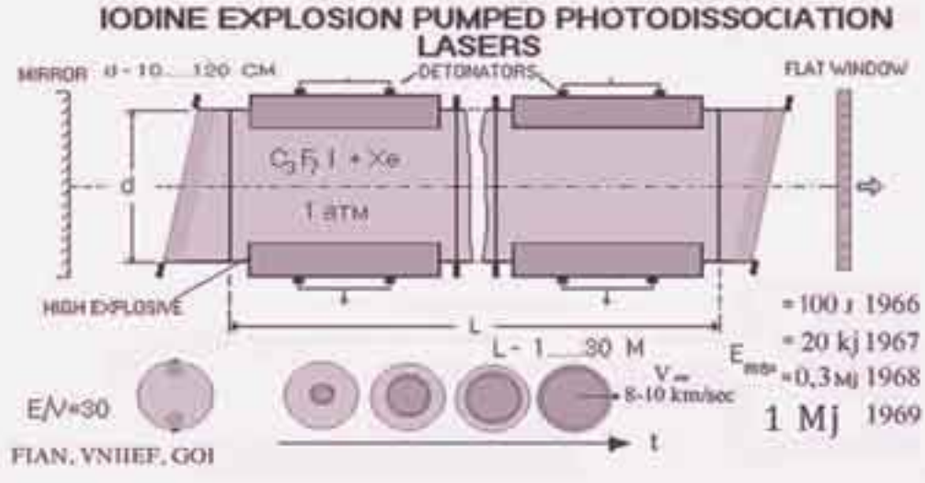
Photodissociation Iodine Laser pumped by explosion shock wave front radiation (EPDL)

In 1964 J.V.V.Kasper, G.C.Pimentel reported the first PDL. In 1965 N.G. Basov and O.N.Krokhin suggested to start a very high energy PDL program in the USSR (T-3) , based on the idea of using explosion shock wave front radiation in Xe as a very high power and energy optical UV pumping source.

The shock wave radiation pumped PDL R&D program for T-3 was started in cooperation of FIAN (V.Zuev et al), VNIIEF (S.Kormer, G.Kirillov et al, Sarov) teams with participation of GOI and GIPKh (Leningrad) teams. "Luch" (V.K. Orlov's team) – designed several industrially produced EPDL models.

V.S.Zuev (Lebedev)
EPDL theory

G.A.Kirillov (VNIIEF)
HE EPDL
experiments



EPDL's had modular design and the pulse energy was determined by number of modules

Частотно-импульсный электроионизационный лазер 3Д01.

Repetitevely pulsed electroionization (e-beam sustained discharge) laser 3D01.

Raman lasers – "summators"

First PDL's demonstrated poor divergence ~ 100 times diffraction limit. In 1966 N.Basov, I.Sobelman with their coworkers proposed to use a HE Raman laser (RL), pumped by poor beam divergence PDL(s) as a solution of the problem. Good RL efficiency and good optical homogeneity of the RL active media (because of good efficiency) produced an effective two-stage laser system. High energy experiments with use of several independent PDL's were performed successfully at the Sary-shagan test ground in Kazakhstan.

Pulsed liquid oxygen Raman laser AJ-5T pulse energy ~ 90 Kj 400 mm aperture Efficiency - 70%

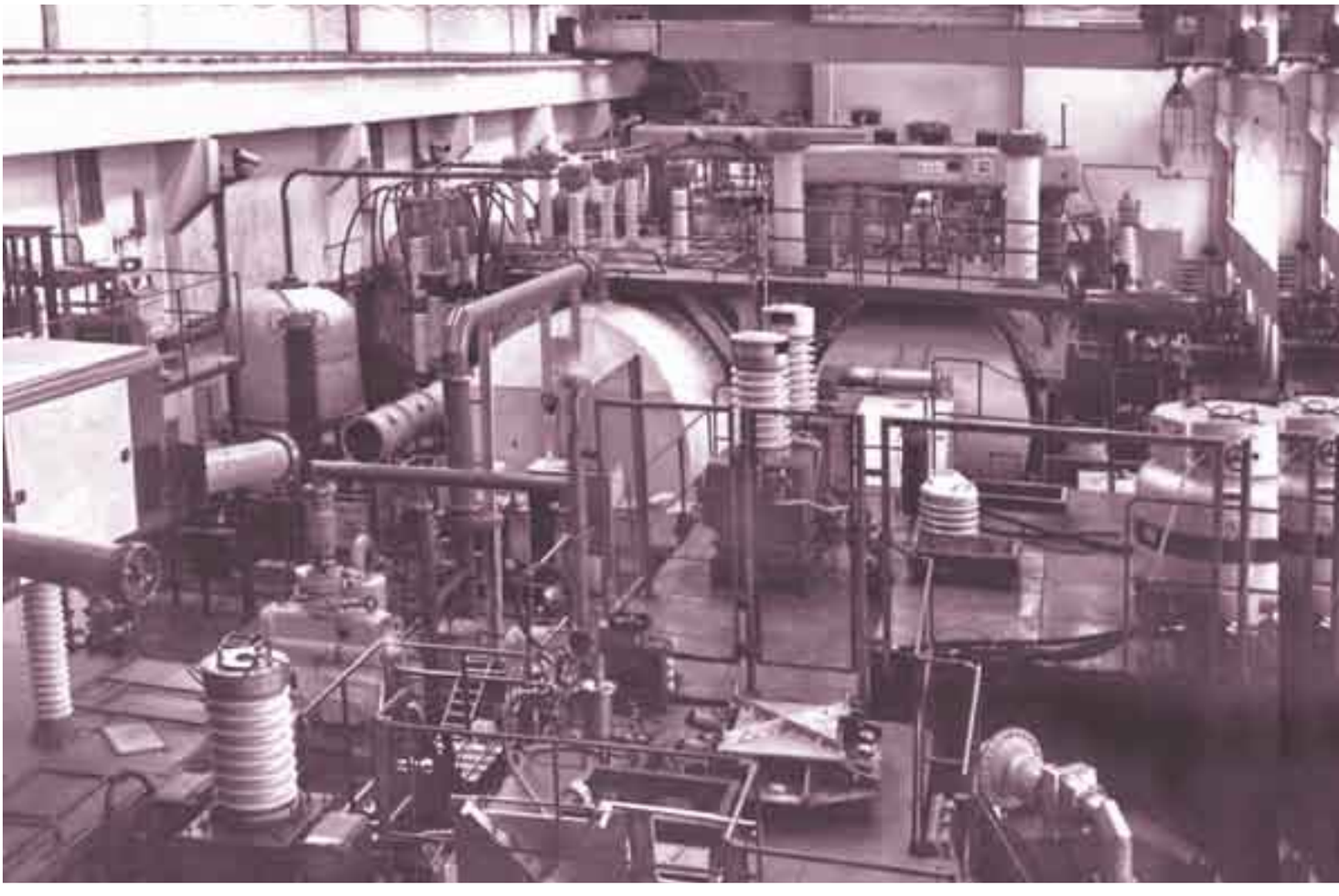
AJ-41 10Kj Raman laser

Multimirror raster optical system used for inserting the radiation of several HE PDL, (outside behind the high quality 3 m fragment protection window)

400 mm glass optics damaged by HE RL radiation –hence fused silica was used

RL test site

E.Zemskov – HE RL summators program leader



CO_2-лазер мегаваттного класса (ОКБ «Радуга»). *Megawatt-class CO_2 laser, (Special Design Bureau «Raduga»).*

ADDITIONAL RESOURCES FOR THE TERRA-3 PROJECT DEVELOPMENT

In 1970–1976, design-and-experimental work on high-power lasers under the scientific leadership of the FIAN continued.

Those works required a significant number of field experiments to work out the design details and to study the propagation of a powerful beam along a real path.

Insufficient testing grounds hampered the development of work not only on PDL, but also on other high-energy lasers: CO_2 and CO lasers, chemical and solid-state lasers. That was soon realized by N. G. Basov, therefore, the search for a laser testing ground began with his support. The site was found 20 km southwest of Vladimir, and the USSR Ministry of Defense agreed to provide it. At the beginning of 1971, a decree of the USSR Government was issued on the development of the Interdepartmental research and test center – «Raduga» *(«Rainbow» in English – ed. remark)* Design Bureau. A pilot plant for the production of high-power lasers was also built.

On the test base, work on lasers of various types: solid-state, CO_2 – and CO-lasers, metal vapor lasers, etc. was carried out. N. G. Basov repeatedly visited the «Raduga» Design Bureau, discussed the results of work on high-power lasers, arranged meetings of the Scientific and Technical Council with the participation of all the leading laser scientists in the country, which were sometimes attended by the presidents of the USSR Academy of Sciences A. P. Alexandrov and G. I. Marchuk.

The results of the work were demonstrated to the leaders of the USSR Government, ministers, military leaders. *(P. V. Zarubin)*

LASER GUIDING

In the autumn of 1981, the largest military exercises were held in the USSR with the involvement of all types and branches of the troops. Not a single battle during the Great Patriotic War involved such an amount of artillery per 1 km of the front line.

The post-war period was characterized by the rapid development of science and technology, which resulted in a change in the parameters of the tactical and operational tasks of the Soviet Army. And the creation and development of such a science as quantum electronics resulted in the development of laser weapons.

In this regard, these exercises worked out the issues of interaction and development of all new types of weapons and the methodology for their use.

In particular, applications in the USSR Armed Forces laser systems, the inventions of which were carried out by a team headed by the outstanding scientist N. G. Basov, were considered. For display at the exercises, laser equipment and performers from among the military unit under my supervision were prepared.

To demonstrate the work of combat crews, Marshal N. V. Ogarkov, academician N. G. Basov were invited to the exercises, to whom Colonel General Mikhailov N. A. reported on the scheme of laser guidance for destruction of enemy defensive equipment.

The result of the work of combat crews was observed by the invited ministers of the USSR defense industry and the leadership of the USSR Armed Forces. The «enemy» was a well-equipped command post that was destroyed by a mortar mine guided by a laser beam.

After the experiment on laser guidance and destruction of the object, academician N. G. Basov assessed positively both the actions of the military personnel and equipment. *(N. A. Mikhailov)*

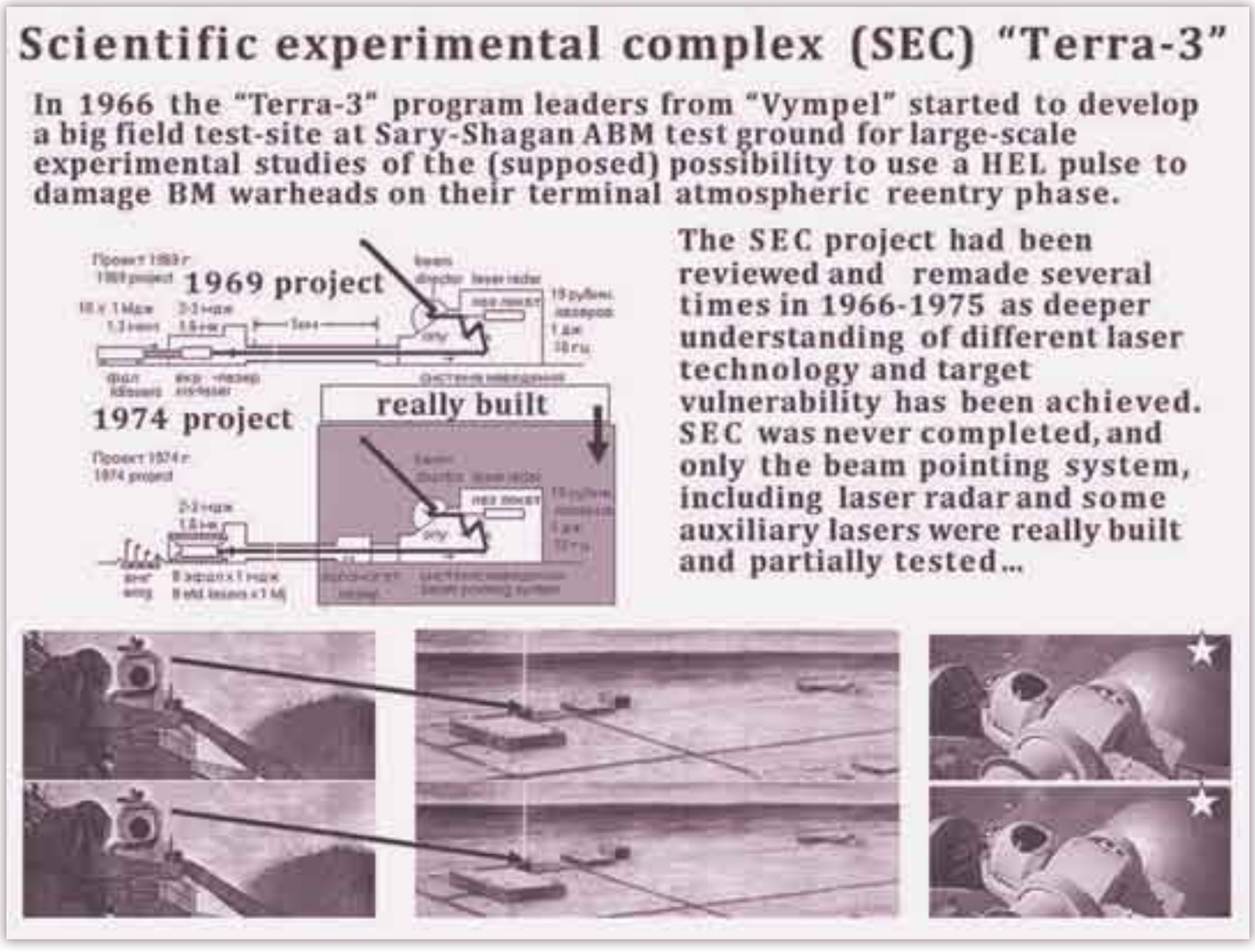
HIGH PRECISION LASER LOCATOR

The range experimental laser installation consisted of the lasers themselves (a block of 19 ruby lasers and a CO_2 laser), the beam guidance and retention system, the information complex designed for ensuring the functioning of the guidance system, as well as the high-precision laser locator 5N27, designed to accurately determine the coordinates of the target.

The capabilities of the 5N27 locator made it possible not only to determine the distance to the target, but also to obtain accurate characteristics of its trajectory, the shape of the object, its size (non-coordinate information).

With the help of 5N27 locator, space objects were observed. Tests were carried out at the complex on the effect of radiation on the target, and on pointing the laser beam at the target.

With the help of the complex, studies were carried out on pointing a low-power laser beam at aerodynamic targets and on the study of the processes of laser beam propagation in the atmosphere. *(P. V. Zarubin)*



RESULTS OF THE DEFENSE PROGRAM

The Terra-3 program resulted in the tremendous rise of both the scientific and technical level of research and development of high energy lasers in the USSR.

The energy parameters of lasers achieved in the late 1960s and mid-1970s has not been surpassed to this day. In the course of research, for the first time, the ideas of nonlinear optics, laser beam phase conjugation, in particular, were applied to high-energy lasers. For many years, the main driving force behind those programs was intellectual power, inexhaustible energy and scientific vision of Nikolai Gennadievich Basov.

In the mid-1980s, laser weapons were tested, which also included targets shooting – aerodynamic targets and ballistic missiles mounted on special stands that simulated various stages of missile flight.

Thus, it was being found out what energy the beam must have in order to hit the target. Those experiments showed that the parameters of the laser beam capable of destroying the head part of ballistic missiles cannot be implemented on the «Terra-3» complex.

The installation was not put into operation and did not work in full, it did not solve combat missions. The construction of the complex was not fully completed – only the guidance system, auxiliary lasers of the guidance system locator and the power beam simulator were installed in full. *(P. V. Zarubin)*

«We failed to make strategic laser weapons, but we have advanced laser physics very well! We have created a good scientific school in the country able to solve complex scientific problems.» *(N. G. Basov)*

Госпремия СССР 1978 года. Слева направо: В. А. Данилычев, И. Б. Ковш, Э. М. Беленов и А. Ф. Сучков. 30 января 1979 г.

The USSR State Prize 1978. Left to right: V. A. Danilychev, I. B. Kovsh, E. M. Belenov, and A. F. Suchkov. 30.01.1979.

Открыто новое явление – обращение волнового фронта. Авторы открытия (слева направо): Ф. С. Файзуллов, Б. Я. Зельдович, В. В. Рагульский, О. Ю. Носач и В. И. Поповичев. 1980 г.

A new phenomenon is discovered: the phase conjugation. The authors of the discovery (left to right): F. S. Faizullov, B. Ya. Zeldovich, V. V. Ragulskii, O. Yu. Nosach and V. I. Popovichev,1980.

Председатель Президиума Верховного Совета СССР Н. В. Подгорный вручает Н. Г. Басову орден Ленина. 1967 г.

Chairman of the Presidium of the USSR Supreme Soviet N. V. Podgorny hands N. G. Basov the Order of Lenin. 1967.

WITH THE SUPPORT OF SKOBELTSYN AND KAPITSA

Quantum radiophysics, or, perhaps more precisely, laser physics, was the subject of Nikolai Gennadievich's constant passion, and all his colleagues and collaborators knew it. Yet 40 years ago, when lasers just appeared, Nikolai Gennadievich predicted almost a new scientific and technological revolution associated with this discovery. Many people thought then that it was too big an exaggeration. However, right now the intensive implementation of lasers into modern technology is taking place – from the use both in endoscopic and ophthalmic operations and in transcontinental communication lines, for ultra-precise measurements and CDs and laser printers. It is obvious that such a long period – 35–40 years which were needed for the start of the impetuous practical development of that fundamental discovery – can be explained by the originality of the discovery, which provided mankind with a device, for the realization of the possibilities of which it was necessary to create a new technological base and revise the existing technical concepts.

One can only marvel at the great intuition of Nikolai Gennadievich – and these are not just nice words, since me myself remember well what skepticism his prediction of the development and introduction of lasers caused among many people.

By the way, here I cannot help mentioning that Nikolai Gennadievich was always supported by Dmitry Vladimirovich Skobeltsyn and that one of those in the Presidium of the USSR Academy of Sciences who showed constant interest in his speeches on that topic was Pyotr Leonidovich Kapitsa. *(O. N. Krokhin)*

Пётр Леонидович Капица,
Николай Геннадиевич Басов.

Peter Leonidovich Kapitsa,
Nikolai Gennadievich Basov.

АКАДЕМИЯ НАУК СССР

ЖУРНАЛ
ЭКСПЕРИМЕНТАЛЬНОЙ
и
ТЕОРЕТИЧЕСКОЙ
ФИЗИКИ

Том 57

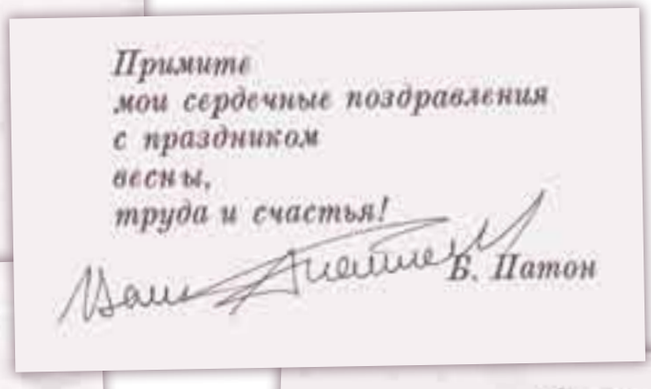
Титульный лист журнала ЖЭТФ с автографом
П. Л. Капицы «Глубокоуважаемому Николаю Геннадиевичу ...»

Title page of the Journal of Experimental and Theoretical Physics (JETPh)
with P. L. Kapitsa's autograph «Dear Nikolai Gennadievich...»

Н. Г. Басов с В. А. Амбарцумяном и его женой

N. G. Basov with V. A. Ambartsumian and his wife.

an Article from SCIENTIFIC AMERICAN



Примите
мои сердечные поздравления
с праздником
весны,
труда и счастья!

Б. Патон

Поздравление с праздником от Б. Патона

Congratulation on the holiday from Boris E. Paton

The Large-Scale Structure of the Universe

Across billions of light-years space is a honeycomb of galactic superclusters and huge voids. The structure may result from perturbations in the density of matter early in the big bang

by Joseph Silk, Alexander S. Szalay and Yakov B. Zel'dovich

Титульный лист и первая страница статьи журнала «Scientific American» с автографом Я. Б. Зельдовича «Глубокоуважаемому Николаю Геннадиевичу ...»

Title and the first page of the Scientific American Journal with Yakov B. Zel'dovich autograph «Dear Nikolai Gennadievich ...»

ON SOME TRENDS IN THE DEVELOPMENT OF ASTROPHYSICS

*2160

V. A. Ambartsumian

Титульный лист журнала «Ann. Rev. Astron. Astrophys.» с автографом В. А. Амбарцумяна «Глубокоуважаемому Николаю Геннадиевичу ...»

Title page of the Ann. Rev. Astron. Astrophys. Journal with Victor A. Ambartsumian autograph «Dear Nikolai Gennadievich ...»

Церемония награждения учёных Академии наук СССР в честь 50-летия Октябрьской революции. Среди присутствующих (в первом ряду) академики: Б. А. Казанский, Б. М. Вул, Г. В. Курдюмов, Д. В. Скобельцын, Я. В. Пейве, М. В. Келдыш, А. Н. Несмеянов и др.; Н. Г. Басов – пятый слева во втором ряду.

Ceremony of rewarding scientists of the USSR Academy of Sciences in honor of the 50th anniversary of the October Revolution. Among those present in the first row – academicians Kazansky B. A., Vul B. M., Kurdyumov G. V., Skobeltsyn D. V., Peive Ya. V., Keldysh M. V., Nesmeyanov A. N. and etc.; in the second row the fifth from the left is Basov N. G.

На Учёном совете. 4 марта 1968 г.

At the Scientific Council. March 4, 1968

MEDICAL LASERS

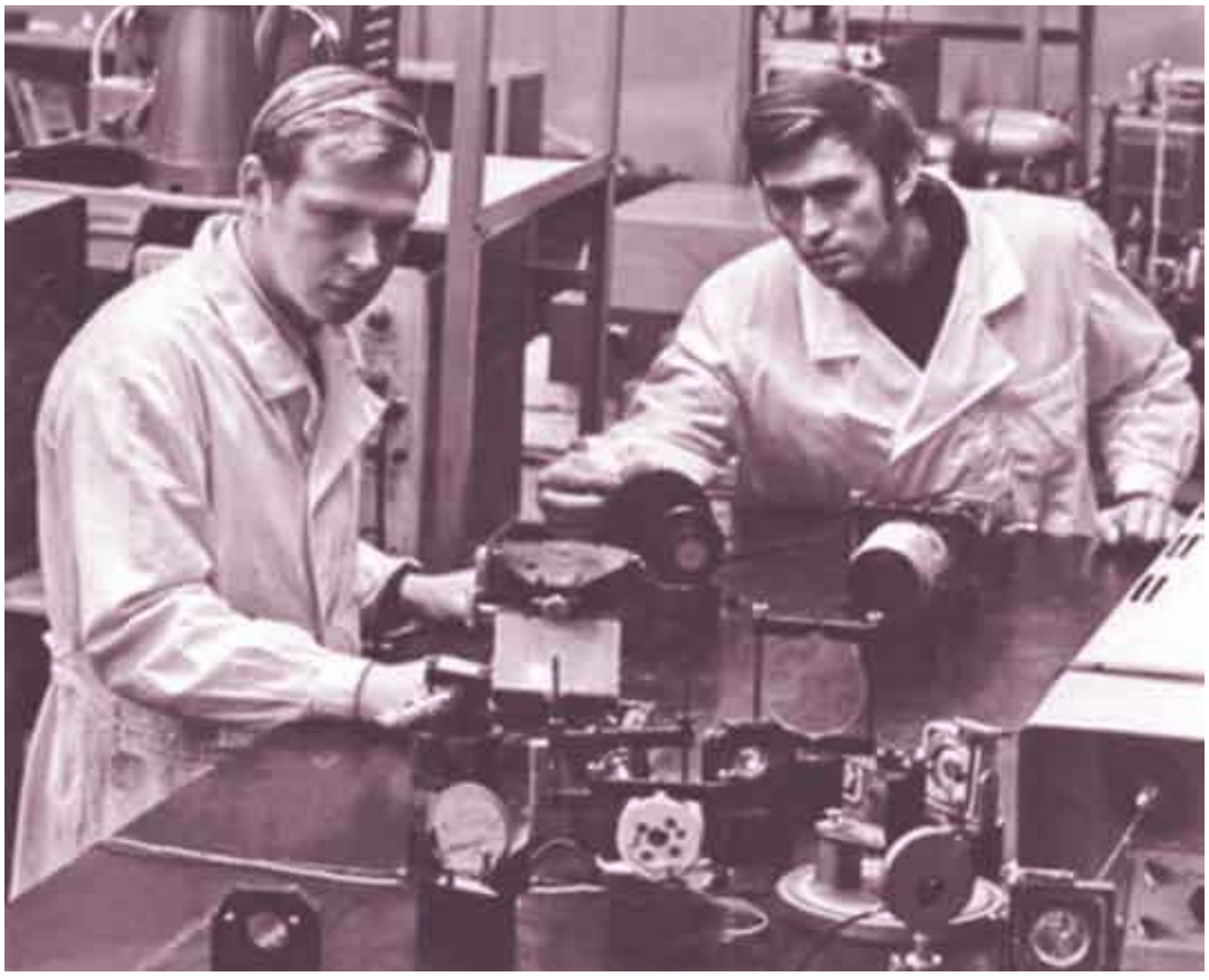
In 1972, N. G. Basov, together with the team he led, became interested in opportunity of endoscopic laser operations – today they are well-known, but then it was the very beginning. Lasers were already used in surgical operations, but to a very limited extent, – in eye surgery: since the eye is transparent it is possible to launch the laser beam into it, and weld the retina if it has detached, or punch a hole in tissues at elevated pressure (glaucoma).

Professor, now a Corresponding Member of the Russian Academy of Medical Sciences Yuri Mikhailovich Pantsirev (he works at the Second Moscow Medical Institute *(now the N. I. Pirogov Russian National Research Medical University – ed. remark))*raised the question of using the endoscope that just appeared at the time. The endoscope is passed into the stomach through the esophagus and allows you to treat various kinds of diseases, primarily the ulcer. The idea was good, but it took about four years to implement it, we studied how radiation affected the gastric mucosa, what wavelength of radiation to choose, how to bring light there, that is, it was necessary to specially produce a channel – the same optical fiber that was used for communication, but different sizes, different elasticity, etc. So, in 1976, together with physicians, we developed a method for coagulating bleeding – it was implemented for the first time in the world. By the way, while the experiments were being carried out the staff of Nikolai Gennadievich Basov's laboratory were waiting for urgent calls at night, because usually massive stomach bleeding requires emergency intervention. Ambulances came for them and urgently took them out to the hospital operating room. *(O. N. Krokhin)*

LASER PROGRESS IN MEDICINE

In 1982, a laser surgery laboratory was established at FIAN. Now this laboratory works in close collaboration with the All-Union Cardiological Center, All-Union Laser Medical Center, Institute of Gastroenterology, Kaunas Medical Institute. As a result of the work, laser operations on the heart and vascular system entered medical practice: formation of a new vascular system of the myocardium by laser channeling, targeted damage of the conduction pathways of the heart (Hiss bundle) in order to combat arrhythmia.

Lasers are widely used for gastric resection operations, treatment of trophic ulcers (CO_2 laser, 60 W), to stop gastric bleeding, remove polyps, sterilize wounds with subsequent increase in the effect of antibiotics (Ar-laser, 10 W). High brightness of laser light seems to be associated with the effectiveness of laser therapy. *(N. G. Basov)*



Инженер П. Д. Березин (слева) и м. н. с. И. Н. Компанец за исследованием свойств управляемых транспарантов, предназначенных для оптической обработки информации. Ноябрь 1972 г.

Engineer P. D. Berezin (left) and junior researcher I. N. Kompanets study the properties of controlled transparencies intended for optical data processing, November 1972.

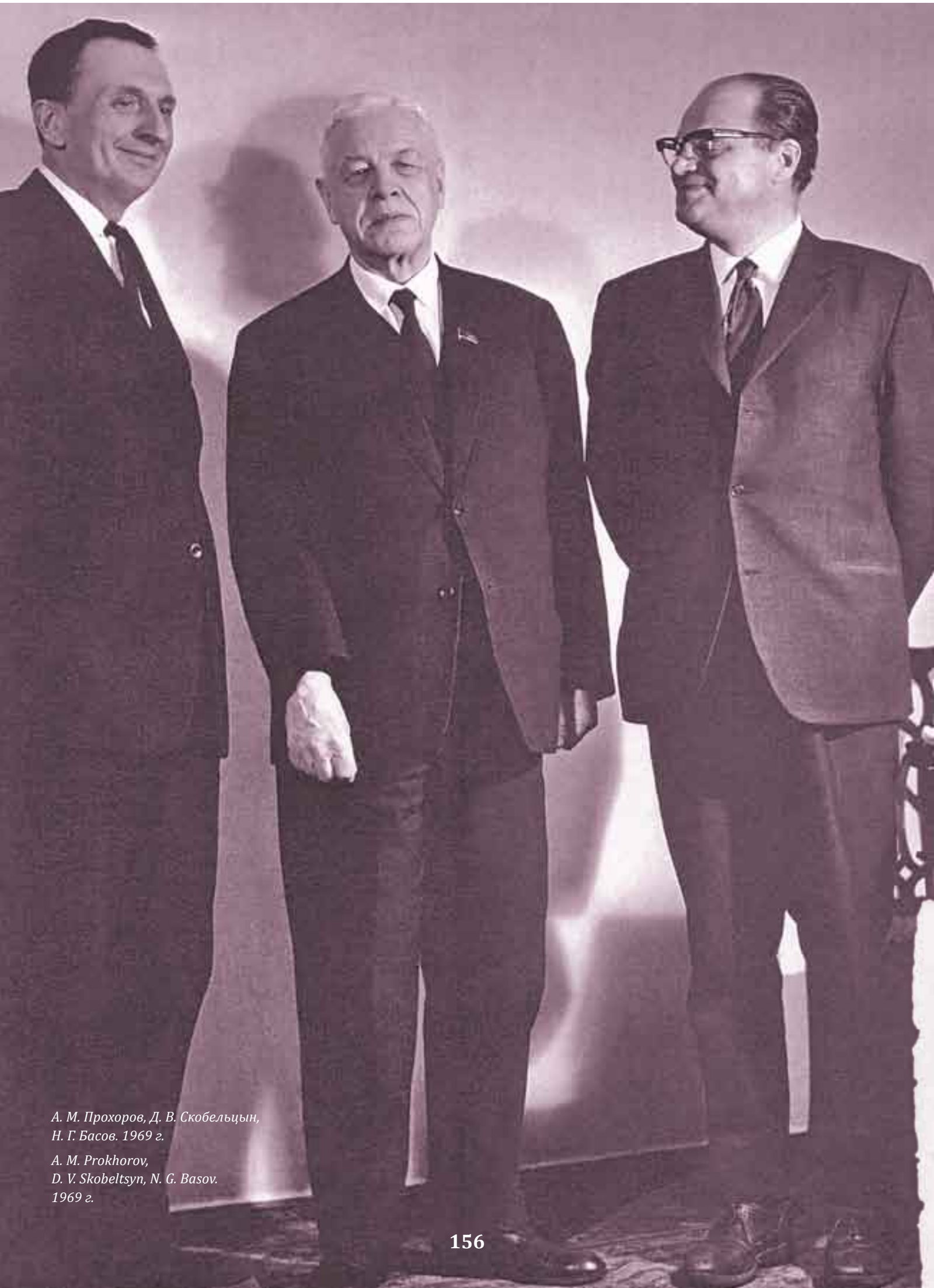
OPTOELECTRONICS

In 1970, on the initiative of N. G. Basov at the Quantum Radiophysics Division (QRPD), within its structure, very actual at that time research was being carried out, the research aimed at creating a parallel computing system operating on the principles, materials and methods of optoelectronics. In particular, the possibility of creating optical switches based on injection lasers, MDM and MDS structures was studied, as well as electrically and optically controlled spatial light modulators (transparency filters), including liquid crystal ones, materials for archival memory and holographic information processing methods, photosensitive detectors and converters of optical signals, etc.

And although electronic calculations turned out to be more efficient, the results of the fundamental research carried out turned out to be in demand for many fields of science and technology, including laser physics, optics, computer science. Those results were awarded three State Prizes, and the following employees of the QRPD became laureates A. P. Bogatov, P. G. Eliseev and B. N. Sverdlov in 1984, A. S. Nasibov also in 1984 and A. A. Vasiliev, I. N. Kompanets, A. V. Parfenov in 1985.

Four teams of employees conducting research in the field of optoelectronics, in 1990 became part of the established Department of Optoelectronics as

- Laboratory of injection lasers,
- Laboratory of semiconductor lasers with electron pumping,
- Laboratory of optoelectronic processors,
- Laboratory of ultrafast Optoelectronics and Information Processing. *(I. N. Kompanets)*



А. М. Прохоров, Д. В. Скобельцын, Н. Г. Басов. 1969 г.

A. M. Prokhorov, D. V. Skobeltsyn, N. G. Basov. 1969 г.

Н. Г. Басов среди учёных, которым присуждено звание Героя Социалистического Труда, у Председателя Президиума Верховного Совета СССР Н. В. Подгорного. 13 марта 1969 г.

N. G. Basov among a group of scientists marked by the title of the Hero of Socialist Labor at the chairman of thePresidium of the USSR Supreme Soviet N. V. Podgorny. March 13, 1969.

THE HERO OF SOCIALIST LABOR

Great is the contribution of N. G. Basov to the organization of works on quantum electronics. Following his initiative, a number of branch research institutes engaged in various applied tasks of laser technology were established. These research institutes work closely and fruitfully with FIAN scientists in solving urgent problems of creation and industrial implementation of quantum electronics devices.

Under the leadership of N. G. Basov, a number of comprehensive programs for the development of the most important areas of quantum electronics were developed and implemented.

As a result of this activity, N. G. Basov was awarded the Star of the Hero of Socialist Labour.

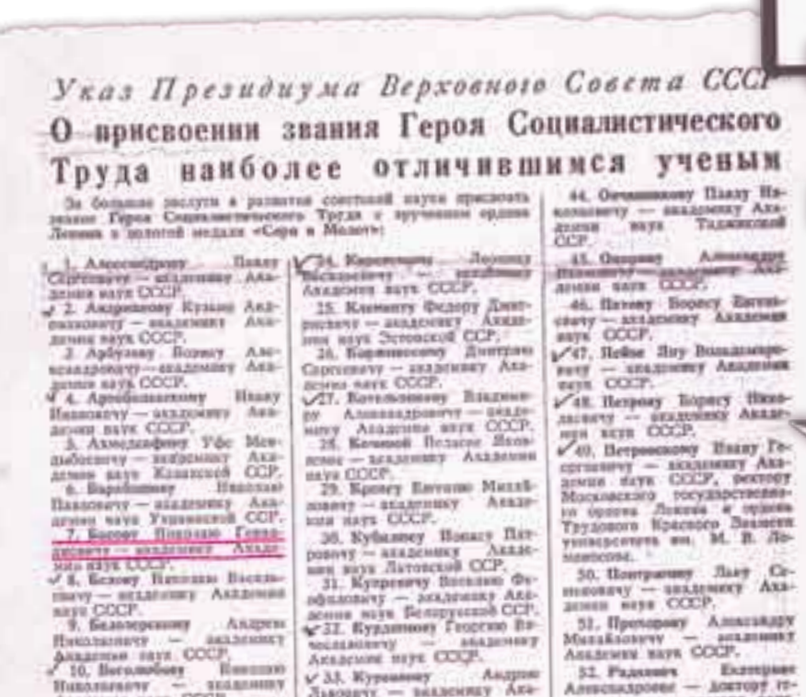
ГЕРОЮ СОЦИАЛИСТИЧЕСКОГО ТРУДА

Тов. БАСОВУ
Николаю Геннадиевичу

За большие заслуги в развитии советской науки

ПРЕЗИДИУМ ВЕРХОВНОГО СОВЕТА СССР

СОЮЗ СОВЕТСКИХ СОЦИАЛИ-



Указ Президиума Верховного Совета СССР

О присвоении звания Героя Социалистического Труда наиболее отличившимся ученым

За большие заслуги в развитии советской науки присвоить звание Героя Социалистического Труда с вручением ордена Ленина и золотой медали «Серп и Молот»:

1. Александрову Павлу Сергеевичу — академику Академии наук СССР.
2. Андрианову Кузьме Андриановичу — академику Академии наук СССР.
3. Арбузову Борису Александровичу — академику Академии наук СССР.
4. Артоболевскому Ивану Ивановичу — академику Академии наук СССР.
5. Ахмеджанову Уфе Мавлютовичу — академику Академии наук Казахской ССР.
6. Барабашову Николаю Павловичу — академику Академии наук Украинской ССР.
7. Басову Николаю Геннадиевичу — академику Академии наук СССР.
8. Белову Николаю Васильевичу — академику Академии наук СССР.
9. Белоусовскому Андрею Николаевичу — академику Академии наук СССР.
10. Беляеву Николаю Николаевичу — академику

24. Кириллову Леониду Васильевичу — академику Академии наук СССР.
25. Клементу Федору Дмитриевичу — академику Академии наук Эстонской ССР.
26. Барановскому Дмитрию Сергеевичу — академику Академии наук СССР.
27. Кочельяевскому Владимиру Александровичу — академику Академии наук СССР.
28. Кочиной Полине Яковлевне — академику Академии наук СССР.
29. Крицу Евгению Михайловичу — академику Академии наук СССР.
30. Кубилюсу Повасу Пятровичу — академику Академии наук Литовской ССР.
31. Купревичу Василию Федосеевичу — академику Академии наук Белорусской ССР.
32. Кудрявцеву Георгию Владимировичу — академику Академии наук СССР.
33. Курошеву Андрею Г... — академику Ака-

44. Очаповскому Павлу Ивановичу — академику Академии наук Таджикской ССР.
45. Овчарову Александру Павловичу — академику Академии наук СССР.
46. Патону Борису Евгеньевичу — академику Академии наук СССР.
47. Пейве Яну Владимировичу — академику Академии наук СССР.
48. Петрову Борису Николаевичу — академику Академии наук СССР.
49. Петровскому Ивану Георгиевичу — академику Академии наук СССР, ректору Московского государственного ордена Ленина и ордена Трудового Красного Знамени университета им. М. В. Ломоносова.
50. Понтрягину Льву Семеновичу — академику Академии наук СССР.
51. Прохорову Александру Михайловичу — академику Академии наук СССР.
52. Радкевич Екатерине Александровне — доктору ге-

За большие заслуги в развитии советской науки Николай Геннадиевич Басов был награждён 13 марта 1969 года Звездой Героя Социалистического Труда.

For great achievements in the development of Soviet science Nikolai Gennadievich Basov was awarded the Star of the Hero of Socialist Labor in March 13, 1969.

После вручения ФИАНу ордена Ленина. Кремлёвский Дворец съездов (1969 г.). В первом ряду (слева направо): Н. Г. Басов, А. Н. Лебедев, Д. В. Скобельцын, А. И. Исаков, П. А. Черенков.

After FIAN was awarded the Order of Lenin. The Kremlin Palace of Congresses (1969). In the first row from left to right: N. G. Basov, A. N. Lebedev, D. V. Skobeltsyn, A. I. Isakov, P. A. Cherenkov.

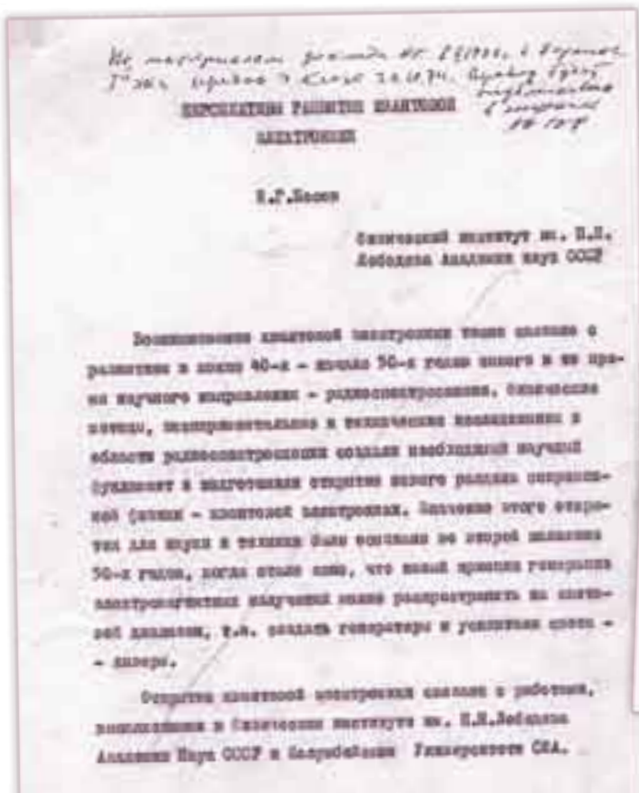
POLYPHYSICAL NATURE OF THE INSTITUTE

The complexity of the work allows FIAN to successfully solve its task: to ensure the emergence and development of new areas of physics. The staff of the institute includes scientists of practically all physical specialties – researchers of both micro- and macrocosms. High energy and cosmic ray physics, theoretical physics, optics, quantum electronics, plasma and space physics, semiconductors, superconductivity...

Such a polyphysical nature of FIAN, which implies the unity of diverse studies practically on the whole front of physical science with the focus on several main directions, makes it possible not to miss a single major problem in the development of science or economy of the country. This polyphysical nature of the Lebedev Institute being developed allowed one, to select full-grown groups and laboratories as independent scientific institutions, without changing FIAN's nature without violating the wholeness of the Institute, preserving its main value – a unique scientific team. *(N. G. Basov)*

Текст доклада Н. Г. Басова «Перспективы развития квантовой электроники.

The text of Basov's report «Prospects for the Development of Quantum Electronics»



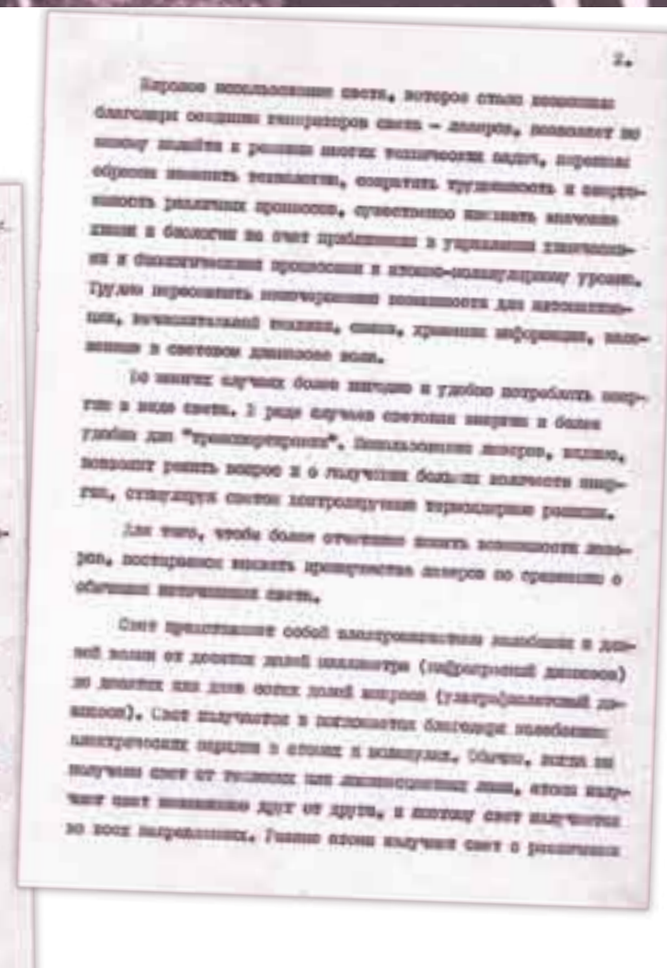
ПЕРСПЕКТИВЫ РАЗВИТИЯ КВАНТОВОЙ ЭЛЕКТРОНИКИ

Н.Г.Басов

Физический институт им. П.Н. Лебедева Академии наук СССР

Возникновение квантовой электроники тесно связано с развитием в конце 40-х – начале 50-х годов нового и важного научного направления – радиоспектроскопии. Физические методы, экспериментальные и технические достижения в области радиоспектроскопии создали необходимый научный фундамент и подготовили открытие нового рода неравновесной среды – инвертных электронах. Значение этого открытия для науки и техники было осознано во второй половине 50-х годов, когда стало ясно, что новый принцип генерации электромагнитных излучений можно распространить на оптический диапазон, т.е. создать генераторы и усилители света – лазеры.

Открытие квантовой электроники связано с работами, выполненными в Физическом институте им. П.Н.Лебедева Академии Наук СССР и Колумбийском Университете США.



2.

Широкое использование света, который стал возможным благодаря созданию генераторов света – лазеров, позволяет по новому подойти к решению многих технических задач, коренным образом изменить технологии, сократить трудоемкость и энергоемкость различных процессов, существенно поднять качество жизни в биологии за счет проникновения в управление химическими и биологическими процессами и атомно-молекулярный уровень. Трудно перечислить многочисленные возможности для использования, вычислительной техники, связи, хранения информации, излучения в световом диапазоне волн.

Во многих случаях более выгодно и удобно потреблять энергию в виде света. В ряде случаев световая энергия и более удобна для "транспортировки". Использование лазеров, видимо, позволит решить вопрос и о получении больших количеств энергии, открывших светом контролируемые термоядерные реакции.

Для того, чтобы более отчетливо понять возможности лазеров, постараемся выяснить преимущества лазеров по сравнению с обычными источниками света.

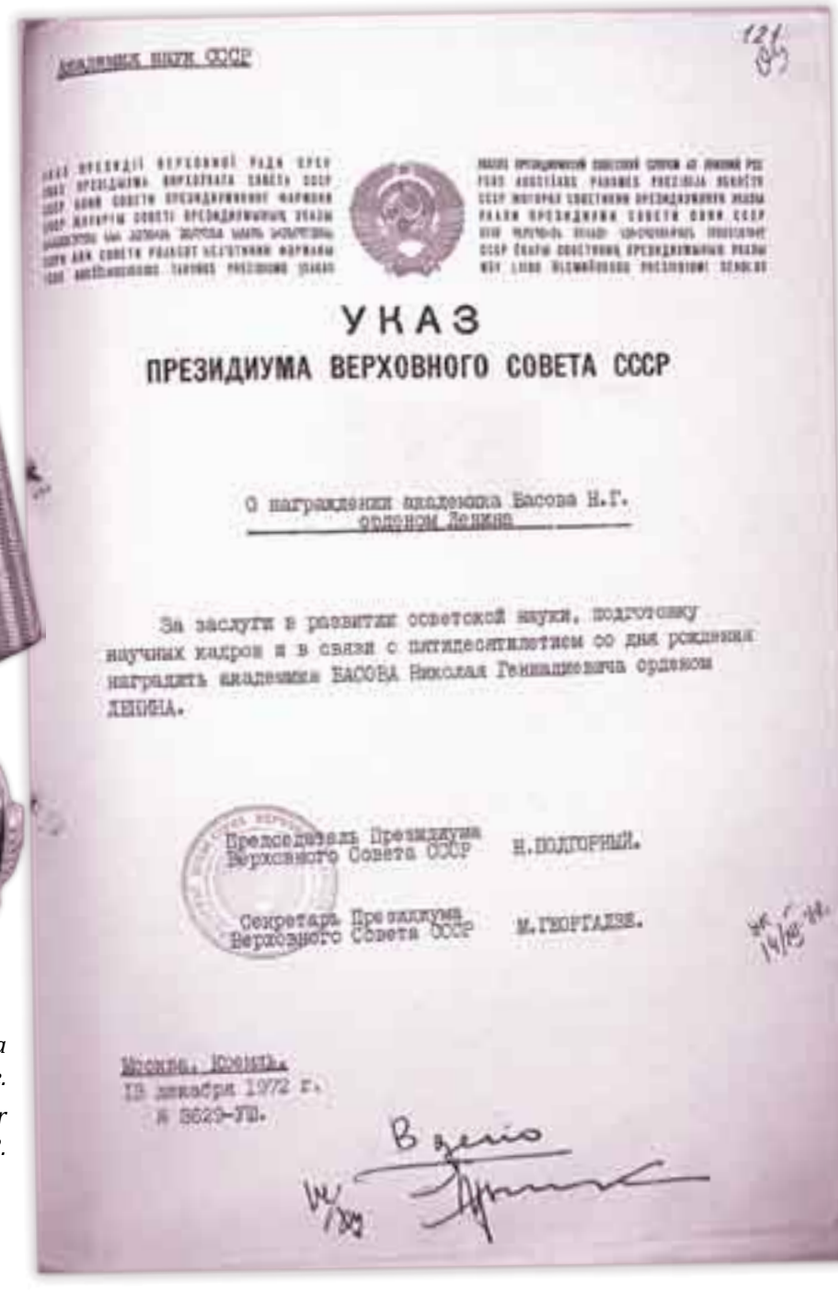
Свет представляет собой электромагнитные колебания и волны от длинных волн инфракрасного (инфракрасный диапазон) до длинных или даже очень длинных (ультрафиолетовый диапазон). Свет излучается и поглощается благодаря колебаниям электронных зарядов в атомах и молекулах. Обычно, когда мы получаем свет от тепловых или люминесцентных ламп, атомы излучают свет независимо друг от друга, и поэтому свет излучается во всех направлениях. Говорят атомы излучают свет с различными

Н. Г. Басов с президентом АН СССР М. В. Келдышем.

N. G. Basov with the President of the USSR Academy of Sciences M. V. Keldysh.

Приказ о награждении академика Н. Г. Басова орденом Ленина. 13 декабря 1972 г.

Order on awarding academician N. G. Basov the Order of Lenin. December 13, 1972.



Академии наук СССР

УКАЗ

ПРЕЗИДИУМА ВЕРХОВНОГО СОВЕТА СССР

О награждении академика Басова Н.Г. орденом Ленина

За заслуги в развитии советской науки, подготовку научных кадров и в связи с пятидесятилетием со дня рождения наградить академика БАСОВА Николая Геннадиевича орденом ЛЕНИНА.

Председатель Президиума Верховного Совета СССР Н.ПОДГОРНЫЙ.

Секретарь Президиума Верховного Совета СССР М.ГЕОРГАДЗЕ.

Москва, Кремль,
13 декабря 1972 г.
№ 5629-УШ.

DIRECTOR OF THE P. N. LEBEDEV PHYSICAL INSTITUTE (FIAN)

<…> Speaking about the results of N. G. Basov's activity, first of all, one should mention the unique team of the Laboratory of Quantum Radiophysics that just bit by bit was getting together around him from the beginning of the 50s, from the first steps of his scientific activity. By the mid-1980s it consisted of more than 300 scientists and specialists. Many important areas of laser physics were born there, theoretical and experimental research related to the development, creation and application of lasers in scientific research and many other areas was carried out. The Basov's Laboratory (later the Department/Division) of Quantum Radiophysics was well known in the scientific world and influenced significantly the activities of domestic and foreign scientists for decades.

Moreover, the role of Nikolai Gennadievich himself was exceptionally high. He himself determined the topics of research or, with the development of the team he supported the ideas and proposals of his co-workers. He was aware of all current work, so meetings with and visits to him were not only the reports on the implementation of the tasks, but they were also interesting and useful discussions for the participants. The work of the Laboratory was under close attention of foreign scientists. Soviet scientific journals and FIAN preprints were promptly translated in the West.

Not once, our participants of international non-laser conferences told me that, having learned where they were working, the foreigners asked a lot of questions about the newly published papers of the laboratory staff, which had nothing to do with the subject of the conference. <…>

<…> Basov's scientific and organizational activity was of great importance not only for his Laboratory, but also for the work of all the staff of the Physical Institute, for its development from the beginning of the 60s to the end of the 80s. It was just at that time when FIAN, (it was called a «polyphysical» institute then), entered a number of advanced centers of physical science in the USSR.

In 1958, the thirty-six-year-old Doctor of Physical and Mathematical Sciences N. G. Basov was appointed deputy director of FIAN. Having worked in this position till 1973, he replaced D. V. Skobeltsyn as the director and headed the Institute till 1988. His circle of contacts was unusually wide and included employees of all specialities and ranks. Together with Skobeltsyn, he regularly (in the usual course of work) visited all divisions, including the branches. In addition, he did a lot of public work, and that caused the jealousy of his co-workers, who thought they were not given sufficient attention. For a certain period, he was at the same time the secretary of the FIAN Communist party committee.

In the first years of his deputy directorship, Basov got acquainted in detail with the topics and the state of affairs in all laboratories, which later enabled him to effectively help them both in the scientific and administrative aspects. His high prestige among the FIAN staff could be explained, first of all, by his talent as a universal physicist and his passion for everything new. He quickly went deep into the work, sought to highlight the key problems and find solutions, involving the participants into the discussions by his ideas and conviction.

Such visits and attention, as well as real support of the administration in search of funding and equipment, stimulated scientific activity and inspired the employees, developing a creative working atmosphere in the teams. All this applies not only to lasers, but also to all scientific research areas of the Institute of that time without exception: semiconductor physics, optics, spectroscopy and luminescence, radio astronomy, plasma and accelerator physics, nuclear and space physics, solar physics, cryogenic technology, etc. Many researches were carried out according to the decisions of higher organizations and other institutions. <…>

<…> Evidently, believing that new knowledge comes from experience, he paid much attention to

Н. Г. Басов на Радиоастрономичеекой станции ФИАН в г. Пущино с заведующим лабораторией А. Д. Кузьминым (слева) и главным конструктором радиотелескопов П. Д. Калачёвым,1980 г.

N. G. Basov at the FIAN Radio Astronomy Station in the town of Pushchino (Moscow Region) with the head of the laboratory A. D. Kuzmin (left) and chief designer of radio telescopes P. D. Kalachev (right),1980.

Награждение ФИАН орденом Октябрьской революции в Колонном зале Дома Союзов. Директор ФИАН Н. Г. Басов – на переднем плане со знаменем ФИАН. Слева– заместитель Председателя Совета Министров СССР, председатель Государственного комитета СССР по науке и технике Г. И. Марчук. Справа – сотрудник ФИАН А. И. Головашкин, слева от него – академик Г. К. Скрябин. Москва, май 1984 г.

FIAN is awarded the Order of the October Revolution in the Hall of Columns, the House of Unions. Director of FIAN N. G. Basov with the banner of FIAN is in the foreground. Left – Deputy Chairman of the Council of Ministers of the USSR, Chairman of the USSR State Committee for Science and Technology G. I. Marchuk. Right – FIAN scientist A. I. Golovashkin, to the left of him – Academician G. K. Scryabin. Moscow, May 1984

improving the accuracy of physical measurements, as well as setting up new experiments and designing special physical installations for it.

With active support, and sometimes on the initiative of Basov, radio telescopes, accelerators, large plasma facilities, high-power lasers were under development at FIAN, several laboratories and departments were engaged in the work on the programs and equipment for space research from satellites and ground stations, for the first time in the world the technological processes for mass production of targets for laser thermonuclear fusion were developed, the relevant technological installations were designed, and their small-scale production for domestic and foreign laboratories was set up at Troitsk site of the Lebedev Physical Institute.

At the dawn of the laser era, in his own laboratory, he began working on quantum frequency standards and laser ranging of the Moon and satellites, that resulted in multiple increase in measurement accuracy. In early 1960s, a hydrogen maser was developed at FIAN.

Only 10 years later N. G. Basov became the director of the Institute, but his exceptional abilities of scientific foresight, the ability to find and involve talented people, and the state-oriented approach to business are already manifesting themselves. <…>

<…> On the background of his wide range of interests, one should mention Basov's special attitude to theoretical research, and that was also noted by D. V. Skobeltsyn. He was even more inspired if the current work led into little-studied areas of physics or when subtle and deep problems arose. In these cases, he was ready to turn to the greatest scientists.

They say that, being a young researcher, he discussed the problems of the quantum theory of radiation in connection with the concept of a laser with L. D. Landau. Soon after the idea of laser thermonuclear fusion appeared he launched joint research works with the team of A. N. Tikhonov and A. A. Samarsky, prominent specialists in mathematical physics and computational mathematics, and with the theorists of nuclear centers in Sarov and Snezhinsk. Many of them are still ongoing. From his student years, Nikolai Gennadievich was on friendly terms with the outstanding nuclear theorist A. M. Baldin.

He knew well many members of the Theoretical Division of the Lebedev Physical Institute, treating them as partners, who could always give a qualified piece of advice and with whom he could freely discuss a wide range of scientific problems that were of great interest for him. Shortly after he had found his own laboratory, he formed a group of theorists in it, which later became a sector. He constantly drew their attention to the problems on which the experimenters worked, and at the same time supported those who turned to the fundamental and difficult problems of physics. There were many theorists among his closest co-workers and deputies.

The Crimean scientific station for laser ranging of satellites and the Moon in the village Katsiveli, Special Faculty of Physics (N. G. Basov Higher School of Physicists) and two chairs at NRNU MEPhI; the digest, and later the journal «Quantum Electronics»; the Journal of Soviet Laser Research, later the Journal of Russian Laser Research; Kuibyshev (Samara) branch of FIAN – these are the results of N. G. Basov's ideas, of the practical work of him personally and of his collegues. Many of these ideas and initiatives still exist today, and they strongly link us with the achievements of Soviet and Russian science. <…> *(A. V. Vinogradov)*

Директор Физического института АН СССР имени П. Н. Лебедева.

Director of the P. N. Lebedev Physical Institute of the USSR Academy of Sciences.

На отдыхе в Крыму. Слева направо: старший сын Н. Г. Басова Геннадий, Н. Г. Басов. В ногах у Басова – младший сын Дима. 1970 г.

On vacation in the Crimea. From left to right: the elder son of N. G. Basov Gennadiy, N. G. Basov. At the feet of Basov – the younger son Dima. 1970.

BEYOND PHYSICS

Only getting older did Nikolai Gennadievich find hobbies that drew him away from physics. Although he was very fond of a river and skiing early in his youth, now he somehow became closer to nature. He was very fond of burning bonfires and could stand by the bonfire for hours deep in thought. Neighbors in the country called him Prometheus.

He loved taking pictures: he had a rich collection of cameras and a huge number of slides. He bought paints going to draw (as a child, he did it). He was very fond of music, especially of Grieg and Rachmaninov, and often listened to tape recordings of their concertos for piano and orchestra. Perhaps music drew him away from heavy thoughts: he was very worried about the current state of affairs in science. *(K. T. Basova)*

Н. Г. Басов в домашней библиотеке.

N. G. Basov in the home library.

Н. Г. Басов, К. Т. Басова и старший сын Геннадий (слева) за игрой в шахматы.

N. G. Basov, K. T. Basova and elder son Gennady (left) playing chess.

Н. Г. Басов и К. Т. Басова готовятся слушать магнитофонные записи.

N. G. Basov and K. T. Basova are preparing to listen to tape recordings.

Ксения Тихоновна с сыном Димой, Николай Геннадиевич со старшим сыном Геннадием. 1964 г.

Kseniya Tikhonovna with the younger son Dmitry and N. G. Basov with the elder son Gennady, 1964.

Хоста. Август 1966 г.
Khosta, August 1966.

Сухуми. 1966 г.
Sukhumi, 1966.

С супругой и сыном Геннадием на рынке в Сухуми. 1966 г.
With his wife and elder son Gennady in the market, Sukhumi, 1966.

Н. Г. Басов со старшим сыном Геннадием на первомайской демонстрации.

N. G. Basov and his elder son Gennady at the May Day demonstration.

Прилёт Н. Г. Басова в Лос-Аламос. Встречают: директор Лос-Аламосской лаборатории профессор Агню, на заднем плане – руководитель лазерной программы профессор Кейт Бойер и О. И. Крохин. Май 1973 г.

Arrival of N. G. Basov to Los Alamos. He is greeted by Director of the Los Alamos Laboratory Prof. Agnew and head of the laser program Prof. Keith Boyer. O. N. Krokhin (in the back), May 1973.

На Гордоновской конференции.
Слева направо: Коробкин, Бойер (США, Лос-Аламос), английский учёный, Н. Г. Басов. Англия, 1978 г.

At the Gordon Conference. From left to right: V. V. Korobkin, Boyer (USA, Los Alamos), an English scientist and N. G. Basov. England, 1978.

Н. Г. Басов с Дж. Эмметом в Лоуренсовской Ливерморской лаборатории, США.

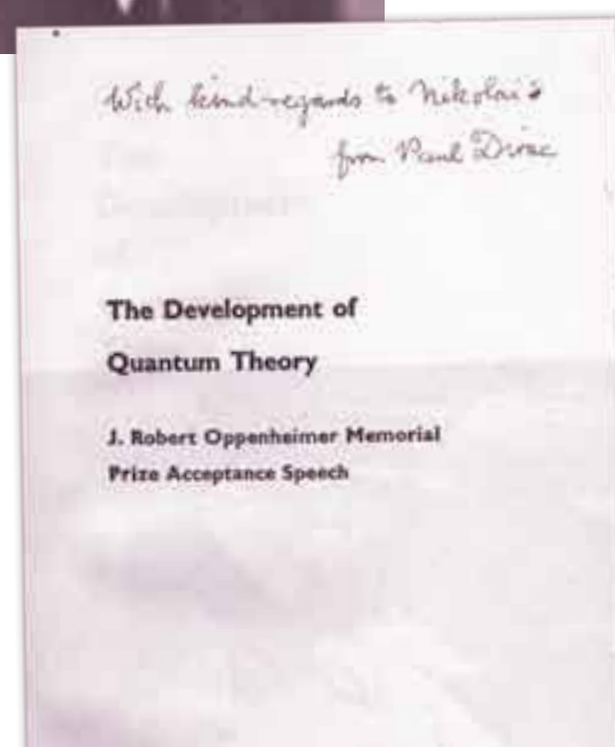
N. G. Basov (right) and J. Emmett (left) in the Lawrence Livermore Lab (USA).

Визит в CNET. 1974 г. *Visit to CNET. 1974*

WIDE RECOGNITION ABROAD

Nikolai Gennadievich Basov is well known abroad. He is a foreign member of the Academy of Sciences of the GDR (1967), the German Academy of Naturalists «Leopoldina» (1971), the Bulgarian Academy of Sciences (1974), the Royal Swedish Academy of Engineering Sciences (1975), the Polish Academy of Sciences (1977), Czechoslovak Academy of Sciences (1977), Academy of Sciences in France (1980), Indian National Academy of Sciences (1986), an Honorary member of the American Optical Society (1972), an Honorary member of the Physical Society of Bulgaria (1972), an Honorary member of the Mark Twain Society (USA, 1977), an Honorary member of the Urania Society (GDR, 1980), TIT Society *(Society for the Propagation of Scientific Knowledge – ed. remark)*, (Hungary, 1981) an Honorary Doctor of Military Technical Academy of Poland (1972), Jena University (1974), Prague Polytechnic Institute (1975), Madrid Polytechnic University (1985), University of Pavia (Italy, 1977).

П. Дирак.
P. Dirac.



Титульный лист речи П. Дирака с автографом при вручении ему мемориальной премии имени Дж. Р. Оппенгеймера.

Title page of P. Dirac's presentation when obtaining the J. R. Oppenheimer Memorial Prize.

Справа: Н. Г. Басов и Г. Веларде в мантиях Мадридского Политехнического университета, в центре – К. Т. Басова.

Right: N. G. Basov and G. Velarde in mantles of the Polytechnic University of Madrid. K. T. Basova at the center.

BREAKFAST WITH DIRAC IN FLORIDA, DINNER WITH SEGRE IN ITALY AT LAKE COMO

During foreign conferences, Nikolai Gennadievich sometimes had unforgettable meetings.

I remember such a meeting, it's hard to believe, a breakfast with Dirac and his wife in Florida during a conference in memory of Robert Oppenheimer. Dirac talked about university life in the USA, to where he moved from England, and then was forced to leave his native University when he reached retirement age. He said that now he was occupied with the problems of the variability of world constants, which was the subject of his reports. At the end of the breakfast, Dirac presented Nikolai Gennadievich with his book «The development of quantum theory», on which he made a warm inscription.

I also remember the meeting with Segre. It took place in Italy on Lake Como, where the150th date of Volta's death was commemorated. Professor Segre invited us for dinner at the hotel where we were staying. The conversation at the table was very emotional – it concerned his scientific work. And I was surprised by his words that he was a fan of Leo Tolstoy and had reread «War and Peace» several times. By the way, he did not deprive me of attention either, advising me to buy natural silk at Como. The dinner was exquisite, starting with soup and ending with sambucus with roasted coffee beans. There were interesting conversations with Segre who was a coworker of Fermi. *(K. T. Basova)*

MADRID MANIFESTO

In 1986, Nikolai Gennadievich Basov was one of more than two hundred scientists who signed the Madrid Manifesto, that proposed international collaboration and cancellation of existing restrictions on research in the field of energy production using inertial fusion. He also took an active part in organizing the Inertial Fusion Energy Society, whose board of directors included, besides him, D'Autray, Nuckolls, Yamanaka, Hora, and me. Academician Basov, setting an example of modesty and simplicity, offered to elect me as a chairman of the council. Unfortunately, all those good intentions were not carried out due to the negative attitude of some nuclear states. *(G. Velarde)*

Вручение медали Э. Теллера. Слева направо: Г. Хора, Н. Г. Басов, Э. Теллер, Д. Наколлс, Ч. Яманака. Япония, 1991 г.

Awarding the E. Teller Medal. Japan, 1991. Left to right: H. Hora, N. Basov, E. Teller, J. Nuckolls, C. Yamanaka.

В гостях у Яманаки. Слева направо: Ч. Яманака, Г. В. Склизкоа, Н. Г. Басов).

Visiting Yamanaka (from left to right: C. Yamanaka, G. V. Sklizkov, N. G. Basov).

Традиционная встреча нобелевских лауреатов.
Traditional meeting of Nobel laureates.

16 ИЮНЯ — ВЫБОРЫ В ВЕРХОВНЫЙ СОВЕТ СССР

КАНДИДАТЫ НАРОДНОГО БЛОКА

В избирательных округах столицы продолжаются встречи с кандидатами в депутаты Верховного Совета СССР.

Одна из встреч состоялась вчера с кандидатом в депутаты Совета Союза Верховного Совета СССР по Октябрьскому избирательному округу Героем Социалистического Труда, лауреатом Ленинской и Нобелевской премий, академиком Николаем Геннадиевичем Басовым.

Открыв собрание, первый секретарь Октябрьского райкома партии Т. П. Архипова предоставила слово доверенному лицу, члену-корреспонденту Академии наук СССР Г. К. Скрябину.

— Биография академика Басова, — сказал он, — яркий пример жизни и деятельности передового советского человека. Н. Г. Басов родился и вырос в трудовой семье, увлеченно учился и работал, с оружием в руках защищал Родину в годы Великой Отечественной войны.

Академик Басов — талантливый ученый, автор выдающихся открытий, председатель Советского комитета защиты мира, председатель физической секции Комитета по Ленинским и Государственным премиям, председатель комиссии ЦК ВЛКСМ по премиям Ленинского комсомола в области науки и техники.

Высокие деловые качества сочетаются у Николая Геннадиевича со скромностью и большим человеческим обаянием, чуткими и заботливым отношением к людям.

Коммунист Басов, кавалер трех орденов Ленина, является замечательным представителем нашей советской народной интеллигенции, воспитанной Коммунистической партией.

В поддержку кандидатуры Н. Г. Басова выступило также доверенное лицо, сборщица 2-го подшипникового завода Г. А. Шахова. Призвав избирателей отдать голоса за кандидата в депутаты Верховного Совета СССР академика Н. Г. Басова, она сказала:

— На заводе развернулось социалистическое соревнование за достойную встречу дня выборов в Верховный Совет СССР. Мы хотим верить вас, что приложу все силы, чтобы оправдать доверие избирателей.

Встречи избирателей с кандидатами в депутаты Верховного Совета СССР состоялись вчера и в ряде других избирательных округов столицы.

Избиратели Тимирязевского округа встретились со своим кандидатом в депутаты — машинистом-инструктором локомотивного депо Лихоборы окружного отделения Московской железной дороги Павлом Ивановичем Новожиловым, избиратели Свердловского округа — с народной артисткой РСФСР, актрисой Театра имени Ленинского комсомола Еленой Алексеевной Фадеевой, Лосиноостровского округа — с машинистом экскаватора строительно-монтажного управления № 9 Метростроя Иваном Тарасовичем Латышевым, Дзержинского округа — с работницей Останкинского мясоперерабатывающего комбината Валентиной Александровной Синявской.

Все встречи прошли в теплой, сердечной об-

Председатель Совета Министров СССР Алексей Николаевич Косыгин с депутатами Верховного Совета СССР – учёным-физиком академиком Николаем Геннадиевичем Басовым и учёным в области автоматического управления, одним из основоположников советской космонавтики академиком Борисом Николаевичем Петровым.

Chairman of the Council of Ministers of the USSR Alexei Kosygin with deputies of the USSR Supreme Soviet – scientist-physicist academician Nikolai Gennadyevich Basov and scientist in the field of automatic control, one of the founders of Soviet cosmonautics academician Boris Nikolaevich Petrov.

Статья из газеты «Вечерняя Москва» от 19 мая 1974 г.

An article from the newspaper Vechernaya Moskva. («Evening Moscow») of May 19, 1974, about the meeting with N. G. Basov, a candidate for deputy of the Supreme Soviet of the USSR.

На заседании Верховного Совета СССР.
Слева направо: в 1-м ряду – М. В. Келдыш, Н. Н. Боголюбов; второй во 2-м ряду – Н. Г. Басов, третий – Р. В. Хохлов.

At the meeting of the USSR Supreme Soviet.
From left to right: in the first row – M. V. Keldysh, N. N. Bogolyubov; in the second row – 2nd – N. G. Basov, 3rd – R. V. Khokhlov.

Шутливый подарок от сотрудников ФИАН к 60-летию Н. Г. Басова: тележка на сцене конференц-зала ФИАН со всеми переплетёнными статьями Н. Г. Басова.

A jocular gift from FIAN employees for the 60th birthday of N. G. Basov: a trolley on the stage of the FIAN conference hall with all the Basov's bound papers

BEING A HIGH-RANKING STATE AND PUBLIC MAN, NIKOLAI BASOV NEVER SEPARATED WITH HIS PASSION FOR SCIENCE

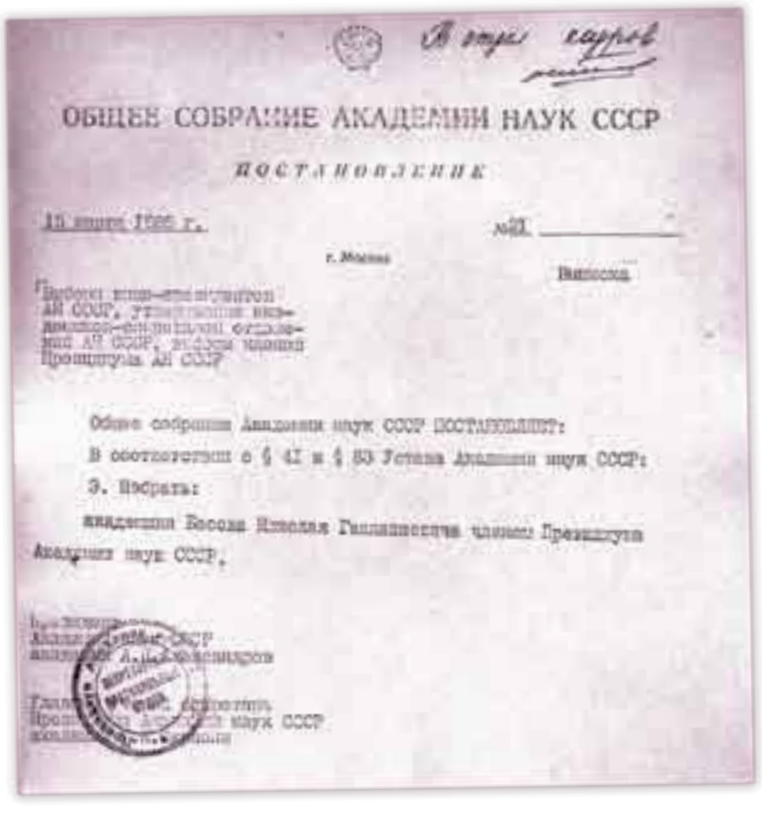
In 1974–1989, Nikolai Gennadievich was elected a deputy of the Supreme Soviet of the USSR, from 1982 to 1989 he was a member of the Presidium of the Supreme Soviet of the USSR. From 1991, he was a member of the Expert Council under the Prime Minister of the Russian Federation.

Советский физик, дважды Герой Социалистического Труда, академик Академии наук СССР Николай Геннадиевич Басов (второй слева) среди делегатов XXVII съезда КПСС в перерыве между заседаниями. Кремлёвский Дворец съездов. 25 февраля 1986 г.

Soviet physicist, twice the Hero of Socialist Labor, academician of the USSR Academy of Sciences Nikolai Gennadievich Basov (the second from left) among the delegates of the XXVII CPSU Congress during a break between sessions. The Kremlin Palace of Congresses. February 25, 1986.

Постановление Общего собрания АН СССР об избрании академика Н. Г. Басова членом Президиума Академии наук СССР.

Resolution of the General Assembly of the USSR Academy of Sciences on the Election of academician N. G. Basov a member of the Presidium of the USSR Academy of Sciences.



ОБЩЕЕ СОБРАНИЕ АКАДЕМИИ НАУК СССР

ПОСТАНОВЛЕНИЕ

Общее собрание Академии наук СССР ПОСТАНОВЛЯЕТ:

В соответствии с § 42 и § 83 Устава Академии наук СССР:

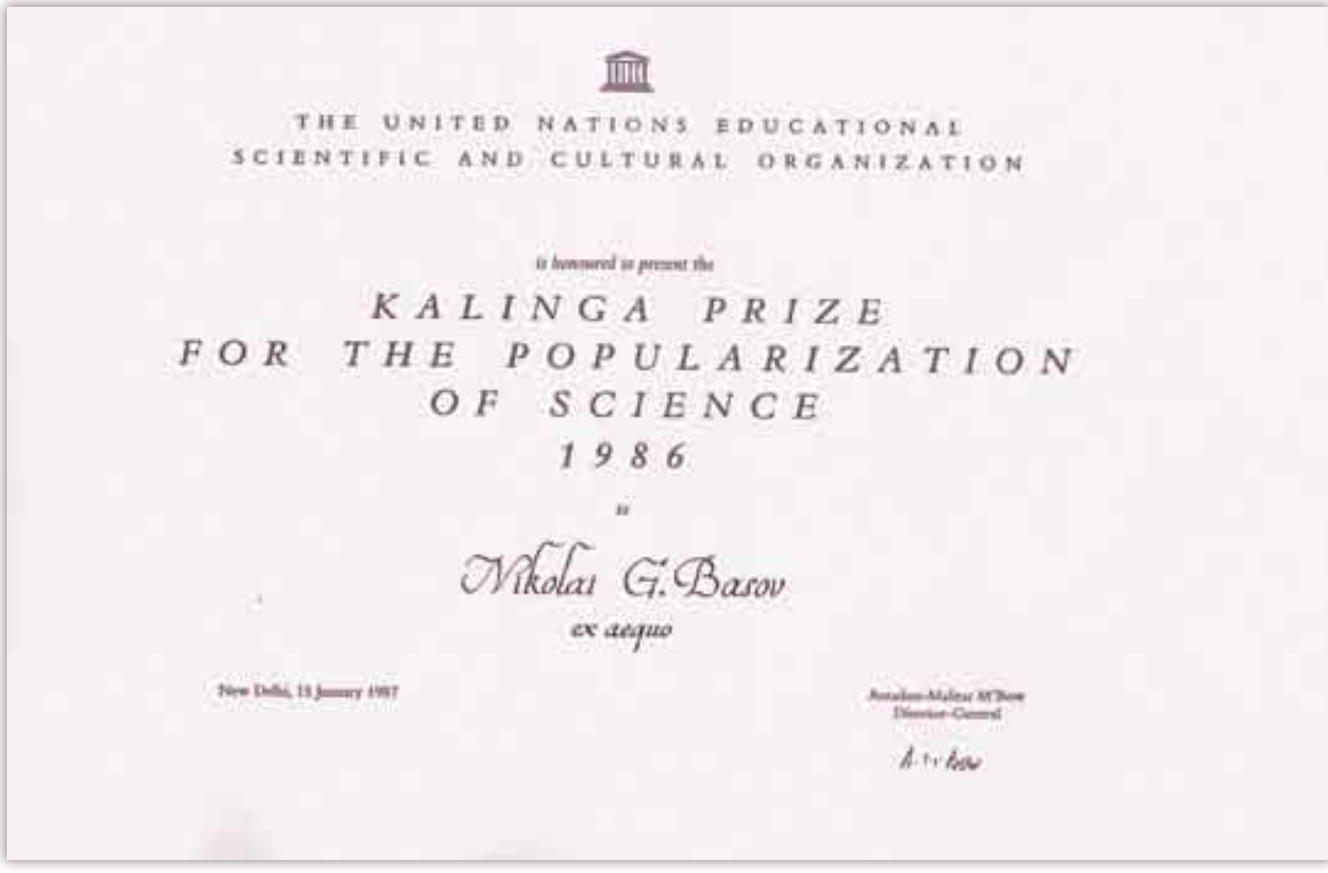
Избрать:

академика Басова Николая Геннадиевича членом Президиума Академии наук СССР.

FUNDAMENTAL SCIENCE AND THE NEEDS OF THE NATIONAL ECONOMY

In our scientific developments we are striving to bring fundamental science closer to the needs of the national economy, to make science work to improve the well-being of the Soviet people. We are working on the creation of thermonuclear energy reactors, in which the fuel is preheated by lasers. How should we use thermonuclear energy in cars, airplanes?

With the help of neutrons obtained in thermonuclear reactors, it is possible to split water into hydrogen and oxygen and thus obtain cheap fuel. In turn, there exists a technology for filling thin-walled glass beads with the diameter of 1–0.5 mm at pressures up to 2000 atmospheres with hydrogen, which makes encapsulated hydrogen a safe and environmentally friendly fuel. It is quite possible that encapsulated hydrogen may become one of the main fuels of the 21st century. *(N. G. Basov)*



THE UNITED NATIONS EDUCATIONAL
SCIENTIFIC AND CULTURAL ORGANIZATION

is honoured to present the

KALINGA PRIZE
FOR THE POPULARIZATION
OF SCIENCE
1986

to

Nikolai G. Basov

ex aequo

New Delhi, 15 January 1987

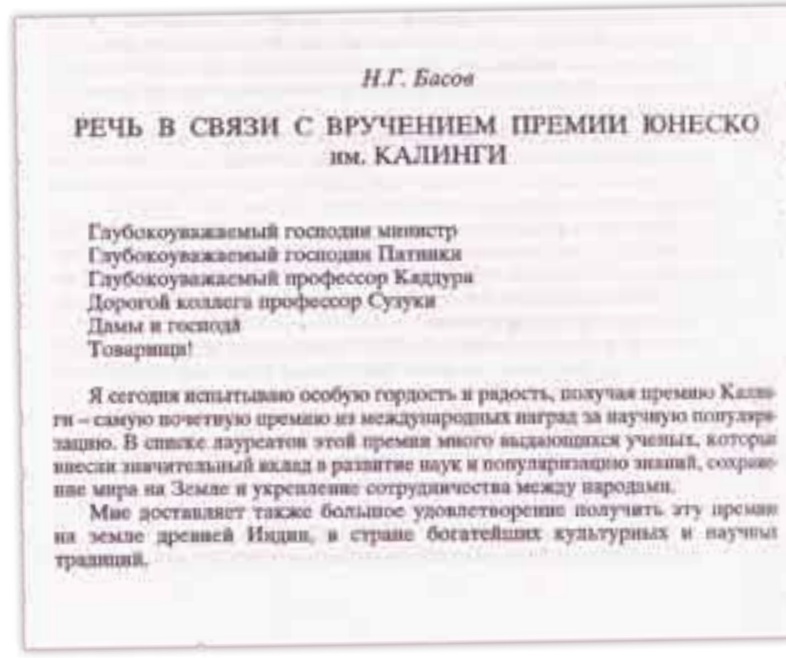
Director-General

Диплом ЮНЕСКО о присуждении премии Калинги за вклад в популяризацию науки и научно-просветительскую деятельность. 1986 г.

Diploma of UNESCO on awarding the Kalinga Prize for the contribution in the popularization of science and educational activity. 1986.

MOST HONORABLE AWARD FOR THE POPULARIZATION OF SCIENCE – KALINGA PRIZE OF UNESCO

For his activity on popularization of science Nikolai Gennadievich was awarded the Kalinga Prize of UNESCO accompanied with the Cook's Around- the-World-Tour which he couldn't use due to being busy. In his speech in connection with awarding the Kalinga Prize in Delhi, India, N. G. Basov said: «The new logic of thinking forbids us to enter the fields associated with the use of nuclear weapons that threaten the destruction of world civilization». *(K. T. Basova)*



Н.Г. Басов

РЕЧЬ В СВЯЗИ С ВРУЧЕНИЕМ ПРЕМИИ ЮНЕСКО им. КАЛИНГИ

Глубокоуважаемый господин министр
Глубокоуважаемый господин Патнаик
Глубокоуважаемый профессор Каддура
Дорогой коллега профессор Сузуки
Дамы и господа
Товарищи!

Я сегодня испытываю особую гордость и радость, получая премию Калинги – самую почетную премию из международных наград за научную популяризацию. В списке лауреатов этой премии много выдающихся ученых, которые внесли значительный вклад в развитие наук и популяризацию знаний, сохранение мира на Земле и укрепление сотрудничества между народами.

Мне доставляет также большое удовлетворение получить эту премию на земле древней Индии, в стране богатейших культурных и научных традиций.

Выступление Н. Г. Басова в связи с вручением премии ЮНЕСКО. 1986 г.

N. G. Basov's speech in connection with the presentation of the UNESCO Prize. 1986.

Along with great scientific and organizational work, Nikolai Gennadievich Basov actively participates in the public life of the country and in international scientific organizations.

A list of N. G. Basov's positions and memberships:

Академик БАСОВ Николай Геннадиевич

Член Президиума АН СССР

Директор Физического института им. П.Н.Лебедева

Профессор Московского инженерно-физического института

Главный редактор журнала "Квантовая электроника"

Главный редактор журнала "Природа" АН СССР

Председатель Правления Всесоюзного общества "Знание"

Председатель Комиссии по лазерному термоядру

Член Высшей аттестационной комиссии

Председатель Советской части совместной комиссии по присуждению премий АН СССР и Польской академии наук

Председатель Экспертной комиссии по премиям, присуждаемым АН СССР и Польской академии наук

Зам.председателя Исполнительного совета Всемирной федерации научных работников

Зам.председателя Комиссии по оптоэлектронике

Зам.председателя Междуведомственно-координационного совета по квантовой электронике

Член Совета директоров Научного центра АН СССР в Красной Пахре

Член координационного совета при МФТИ

Член Научного совета по экономическим проблемам научно-технического прогресса АН СССР

Член Советского комитета защиты мира

Член Комитета по Ленинским и Государственным премиям СССР в области науки и техники

Член Центрального совета методологических семинаров при Президиуме АН СССР

Член Всемирного совета мира

Член Бюро НС по использованию проблем мира и разоружения

Член Совета по связям АН СССР с высшей школой при Президиуме АН СССР и Минвузе СССР

2

Член Межведомственного научно-технического совета по проблемам ядерной технологии

Член Научного совета по комплексной проблеме "Философские и социальные проблемы науки и техники"

Депутат Верховного Совета СССР

Член Президиума Верховного Совета СССР.

Николай Геннадиевич Басов с сыновьями Дмитрием и Геннадием в день своего 60-летия. 1982 г.
Оба сына Николая Геннадиевича закончили тот же институт, что и отец, и тоже стали физиками.

With sons Dmitry and Gennady on the day of his 60th birthday. 1982.
Both sons of Nikolai Gennadievich graduated from the same institute as their father and also became physicists.

FROM AN INTERVIEW WITH DMITRY BASOV AT MOSCOW PHYSICAL-TECHNICAL UNIVERSITY (NOVEMBER 2020)

Question: Tell us about your father, how much did he influence your career? Is that why you went into science, chose physics?

Answer: Yes, yes, yes! My father was in love with physics all his life, and he could talk only about it until his last day, when I came to see him in the hospital. The influence, of course, was very great, and I do not regret at all that I chose physics. This is a unique opportunity to learn new things. My father said that science is the best thing to devote your life to.

Дмитрий Николаевич Басов – профессор физики в Отделе физики Колумбийского университета (США). Его исследования направлены на изучение электронных процессов в квантовых материалах, которые он изучает при помощи разнообразных нано-оптических методик, разработанных в его лаборатории.

Dimitri Basov is a Professor of Physics in the Department of Physics at Columbia University. His research focuses on electronic phenomena in quantum materials that he investigates using a variety of nano-optical techniques developed in his laboratory.

УКАЗ

ПРЕЗИДИУМА ВЕРХОВНОГО СОВЕТА СССР

О награждении Героя Социалистического Труда академика Басова Н.Г. орденом Ленина и второй золотой медалью "Серп и Молот"

За выдающиеся заслуги в развитии физической науки, подготовке научных кадров и в связи с шестидесятилетием со дня рождения наградить Героя Социалистического Труда академика БАСОВА Николая Геннадиевича орденом ЛЕНИНА и ВТОРОЙ ЗОЛОТОЙ МЕДАЛЬЮ "СЕРП и МОЛОТ".

В ознаменование трудовых подвигов Героя Социалистического Труда тов.Басова Н.Г. сооружить бронзовый бюст на родине Героя.

Первый заместитель Председателя Президиума Верховного Совета СССР В.КУЗНЕЦОВ.

Секретарь Президиума Верховного Совета СССР Т.МЕНТЕШАШВИЛИ.

Москва, Кремль.
13 декабря 1982 г.
№ 6447-X.

За выдающиеся заслуги в развитии физической науки, подготовке научных кадров и в связи с 60-летием со дня рождения Николай Геннадиевич Басов был награждён второй золотой медалью «Серп и Молот» и орденом Ленина. 13 декабря 1982 г.

For outstanding services in the development of physical science, training of scientific personnel and in connection with the 60th anniversary Nikolai Gennadievich Basov was awarded the second gold medal «Hammer and Sickle» and the Order of Lenin. December 13, 1982.

Академики М. В. Келдыш и Н. Г. Басов.
Academicians M. V. Keldysh and N. G. Basov.

The scientific and educational activities of Nikolai Gennadievich Basov were extensive and multifaceted: for many years he was the editor-in-chief of the journal «Priroda» *(«Nature» in English – ed. remark)*. In 1971 N. G. Basov founded the journal «Quantum Electronics» and for 30 years was its editor-in-chief.

Журнал «Природа», главным редактором которого долгие годы был Н. Г. Басов.

The journal «Priroda» («Nature») where N. G. Basov was editor-in-chief for many years.

Н. Г. Басов создал журнал «Квантовая электроника» и в течение 30 лет был его главным редактором.

N. G. Basov created the journal «Quantum Electronics» and was its editor-in-chief for 30 years.

FOLLOWING KELDYSH PROPOSAL

I got closely engaged in dissemination of knowledge and popularization of science in 1967 after I was elected a member of the Presidium of the USSR Academy of Sciences. That year, the President of the USSR Academy of Sciences, Academician Mstislav Vsevolodovich Keldysh offered me to be a head of the popular science journal «Priroda» published by the USSR Academy of Sciences

This journal, founded in 1912 by prominent Russian scientists and the outstanding writer A. P. Chekhov, is designed to promote knowledge among academicians, professors, teachers and students.

Its objective is to give true information about the latest achievements of the natural science straight from the source, from the creators of science, prominent scientists, without missing anything significant. *(N. G. Basov)*

SCIENTIFIC CREATIVITY

The main feature of N. G. Basov's scientific work was the focus on a new idea. Apparently, that is why he and his students carried out an unusually large number of researches works, that are commonly called pioneering.

N. G. Basov is a world-class personality. It is difficult to cover his multi-faceted scientific, scientific-organizational, educational and pedagogical activities in a small article, so we refer the reader to other articles and books dedicated to N. G. Basov.

In a large scientific team, raised and led by N. G. Basov, more than sixty people scientists were awarded such prestigious prizes as the Lenin, State, Lenin Komsomol Prize, nominal prizes of the Academy of Sciences.

ЭСТАФЕТА ЗНАНИЙ

(ВСЕСОЮЗНОМУ ОБЩЕСТВУ «ЗНАНИЕ» — 40 ЛЕТ)

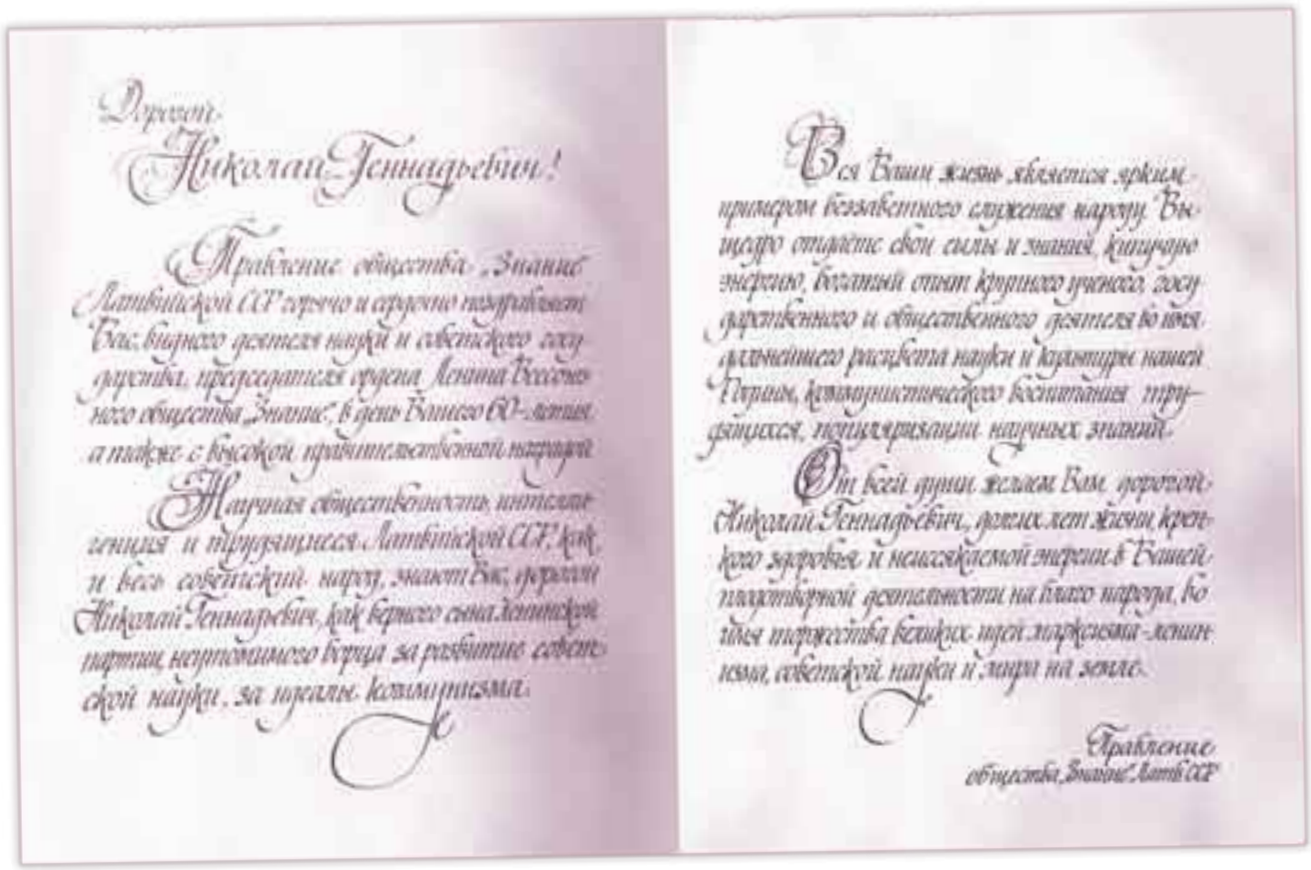
A poster of the Polytechnic Museum: Sunday readings, science and technology news. First presentation «Molecular oscillators and amplifiers» by N. G. Basov.

DISSEMINATION OF KNOWLEDGE

In 1978, I was elected chairman of the board of the All-Union Society «Znaniye» *(«Knowledge» in English – ed. remark)* – the leading organization for the dissemination of scientific and socio-political knowledge in our country. Today, there are more than 2.5 million members of the Society, among them – 2 thousand academicians of the Academy of Sciences of the USSR, republican and branch academies, over 100 thousand professors and teachers, a large number of engineers, teachers, doctors and other specialists. They give over 10 million lectures a year in all fields of knowledge.

The Society «Znaniye» has branches in all the Soviet Union republics, regions, cities and villages; it includes lecture halls, planetariums, scientific and technical creativity centers.

The publishing house of the Society publishes six popular science journals, two popular science newspapers, many books, forty monthly series of brochures to help one's self-education. The total circulation of publications is over 100 million copies. Every third popular science book published in the USSR is published by the «Znaniye» publishing house. *(N. G. Basov)*



Дорогой Николай Геннадьевич!

Правление общества „Знание" Латвийской ССР горячо и сердечно поздравляет Вас, видного деятеля науки и советского государства, председателя совета Ленинградского общества „Знание", в день Вашего 60-летия, а также с высокой правительственной наградой.

Научная общественность, интеллигенция и трудящиеся Латвийской ССР, как и весь советский народ, знают Вас, уважаемый Николай Геннадьевич, как верного сына Ленинской партии, непримиримого борца за развитие советской науки, за идеалы коммунизма.

Вся Ваша жизнь является ярким примером беззаветного служения народу. Вы щедро отдаете свои силы и знания, кипучую энергию, богатый опыт крупного ученого, государственного и общественного деятеля во имя дальнейшего расцвета науки и культуры нашей Родины, коммунистического воспитания трудящихся, пропаганды научных знаний.

От всей души желаем Вам, дорогой Николай Геннадьевич, долгих лет жизни, крепкого здоровья и неиссякаемой энергии в Вашей плодотворной деятельности на благо народа, во имя торжества великих идей марксизма-ленинизма, советской науки и мира на земле.

Правление
общества „Знание" Латв ССР

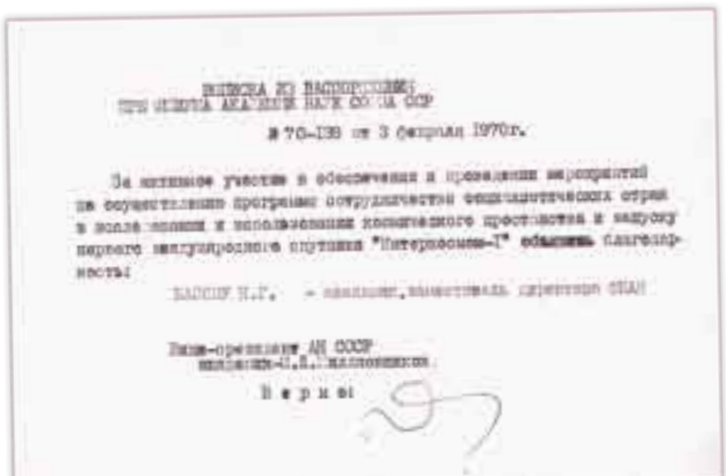
Congratulations to N. G. Basov on the 60th anniversary and the awarding of the Order of Lenin from the Board of the «Znanie» Society of the Latvian SSR.

THE «ZNANIE SOCIETY»

Nikolai Gennadievich gave a lot of his precious time to the «Znanie» (Knowledge) Society, being its Chairman of the Board. There was a lot of work there: lectures were given and many popular journals were published, such as «Science and Humanity», «Quantum», «Arguments and Facts» paper. There were also TV courses in physics and other subjects. Nikolai Gennadievich was awarded the Kalinga Prize of UNESCO just for his work on popularization of science. Nikolai Gennadievich loved books. In his youth, besides scientific literature, he also read a lot of fiction, and then, of course, mostly scientific. He often went to second-hand bookshops. As a result, we had a large library at home. Part of this library is at FIAN now, and his memorial library, consisting of books with autographs and dedicatory inscriptions, has found a place in the Polytechnic Museum. It is considered to be very valuable due to some unique editions. However, it seems to me that the most valuable are, of course, those two books that he carried with him through the entire Great Patriotic War: they are the Einstein's Fundamentals of the Theory of Relativity and the Heitler's Quantum Theory of Radiation. *(K. T. Basova)*

Благодарность от Президиума АН СССР за активное участие в запуске международного спутника «Интеркосмом-I». 3 февраля 1970 г.

Gratitude from the Presidium of the USSR Academy of Sciences for active participation in the launch of international satellite «Intercosmos-I». February 3, 1970.



ВЫПИСКА ИЗ ПОСТАНОВЛЕНИЯ
ПРЕЗИДИУМА АКАДЕМИИ НАУК СОЮЗА ССР

№ 70-139 от 3 февраля 1970г.

За активное участие в обеспечении и проведении мероприятий по осуществлению программы сотрудничества социалистических стран в целях мирного использования космического пространства и запуску первого международного спутника "Интеркосмос-I" объявить благодарность:

ВАСОВУ Н.Г. - академику, заместителю директора ФИАН

Вице-президент АН СССР
академик С.В. Вонсовский

Верно

Н. Г. Басов и И. И. Артоболевский в обществе «Знание»

N. G. Basov and academician I. I. Artobolevskii at «Znanie» Society.

THE ROLE OF THE LEBEDEV INSTITUTE

For almost 40 years, my main work has been carried out within the walls of the oldest research institute in our country – P. N. Lebedev Physical Institute of the USSR Academy of Sciences.

It was founded in 1724 in St. Petersburg by the decree of Peter I *(Peter the Great – ed. remark).*

The work of this nearly 4,000-staff institute covers the most important branches of physics. Introducing our developments into the national economy, we maintain business ties with more than 250 different institutions, design bureaus, clinics, factories and plants.

The Physical Institute has a number of major scientific achievements. These include the discovery and explanation of the Vavilov-Cherenkov effect, the discovery of the principle of auto-phasing, which underlies all modern large particle accelerators; the discovery of the principle of generation and amplification of electromagnetic radiation by quantum systems,

Слева направо: Г. В. Склизков, Ю. М. Попов, Ф. С. Файзуллов, Р. В. Амбарцумян, П. Г. Крюков, Н. Г. Басов.

From left to right: G. V. Sklizkov, Yu. M. Popov, F. S. Faizulov, R. V. Ambartsumian, P. G. Kryukov, N. G. Basov.

which led to the creation of masers and lasers. The Institute's most important achievements also include the development of the principles of thermonuclear devices, including those with magnetic and inertial plasma confinement; discovery of the super-corona of the Sun; discovery of the outer radiation belt of the Earth; creation of semiconductor, photodissociation, gas-dynamic, chemical, electro-ionization and excimer lasers.

The staff of the Institute has created electronic and proton synchrotrons, semiconductor diodes, transistors and solar batteries, the largest radio telescopes for radio waves of the meter and centimeter ranges, and optical locators of the Moon. *(N. G. Basov)*

SCIENCE AND HUMANITY

The work at the Institute gives rich material for generalization and popularization. The main points of my scientific activity were reflected in a number of popular science articles prepared jointly with colleagues for the authoritative international yearbook «Science and Humanity», which is published by the «Znaniye» society.

These are articles about masers and lasers, laser fusion synthesis, optoelectronics, laser technology, location of the Moon.

The study of nonlinear oscillation theory, optical nonlinearity in the interaction of laser light beams with matter helped me to prepare a report for a philosophical conference on the role of nonlinear processes in various fields of human activity. *(N. G. Basov)*

Слева направо: Н. Г. Басов, В. Е. Фортов, Ж. И. Алфёров, Ю. С. Осипов.

From left to right: N. G. Basov, V. E. Fortov, J. I. Alferov, Yu. S. Osipov.

ФИАН

ПРЕЗИДИУМ АКАДЕМИИ НАУК СССР

ПОСТАНОВЛЕНИЕ

1 марта 1990 г. № 426

г. Москва

О присуждении золотых медалей имени М.В.Ломоносова 1989 года /представление Экспертной комиссии/

Президиум академии наук СССР ПОСТАНОВЛЯЕТ:

1. Присудить золотую медаль имени М.В.Ломоносова 1989 года академику Басову Николаю Геннадиевичу за выдающиеся достижения в области физики.

2. Присудить золотую медаль имени М.В.Ломоносова 1989 года профессору Петеру Хансу Альбрехту /США/ за выдающиеся достижения в области физики.

Постановление Президиума АН СССР о награждении Н. Г. Басова Золотой медалью имени М. В. Ломоносова. 1 марта 1990 г.

Decree of the Presidium of the USSR Academy of Sciences on awarding N. G. Basov the M. V. Lomonosov Gold Medal. March 1, 1990.

The problem of laser fusion was still a matter of great importance for N. G. Basov. Many people have heard about tokamaks that can solve the energy problems of mankind. Laser fusion is an alternative idea that has many advantages. Basov believed in it in the 60s, when the energy of lasers was thousands of times less than required. Now the theory has been developed, but in recent years no funds have been found for the experiment. In the US, this area is developing rapidly.

Nikolai Gennadievich paid great attention to the development and education of scientific personnel. In 1977 he initiated the setting of the Department Chair of Quantum Electronics at MEPhI *(Moscow Engineering Physics Institute, now it is called National Research Nuclear Univ. – ed. remark)* and remained its head for 24 years.

He was the founder and head of the Higher School of Physicists at MEPhI and FIAN. Many students and colleges of N. G. Basov became doctors of science, members of the Russian Academy of Sciences. N. G. Basov and his scientific school received the Nobel, three Lenin and seventeen State Prizes. (*O. N. Krokhin)*

HIGHER SCHOOL OF PHYSICISTS NAMED AFTER N. G. BASOV

On the initiative of N. G. Basov, a Special Faculty of Physics (later «the Higher School of Physicists) was organized at MEPhI in 1971 (by the order of the Minister of higher and special education, V. P. Elyutin, and by the order of the President of the USSR Academy of Sciences, M. V. Keldysh). The Special Faculty was aimed at individual training of students in the latest achievements of experimental and theoretical physics. It had dual subordination: FIAN was responsible for scientific work, and MEPhI, for education.

Gifted senior students from higher educational institutions were admitted to the Special Faculty (named later the Higher School of Physicists). Since its foundation, this School has trained students from more than seventy Universities of the Russian Federation and the CIS countries, and more than 1,000 highly qualified specialists have graduated from it. On November 30, 2001, the Higher School of Physicists was awarded the Prize of the President of the Russian Federation and was named after its founder, academician N. G. Basov. In 2017, a monument to N.G. Basov was unveiled at the entrance to the MEPhI as a token of gratitude from the graduates of the Higher School of Physicists. *(K. T. Basova)*

По дороге из Токио в Осаку в форменных фуражках экипажа.

On the way from Tokyo to Osaka in the uniform caps of the crew.

Япония, 1992 г.

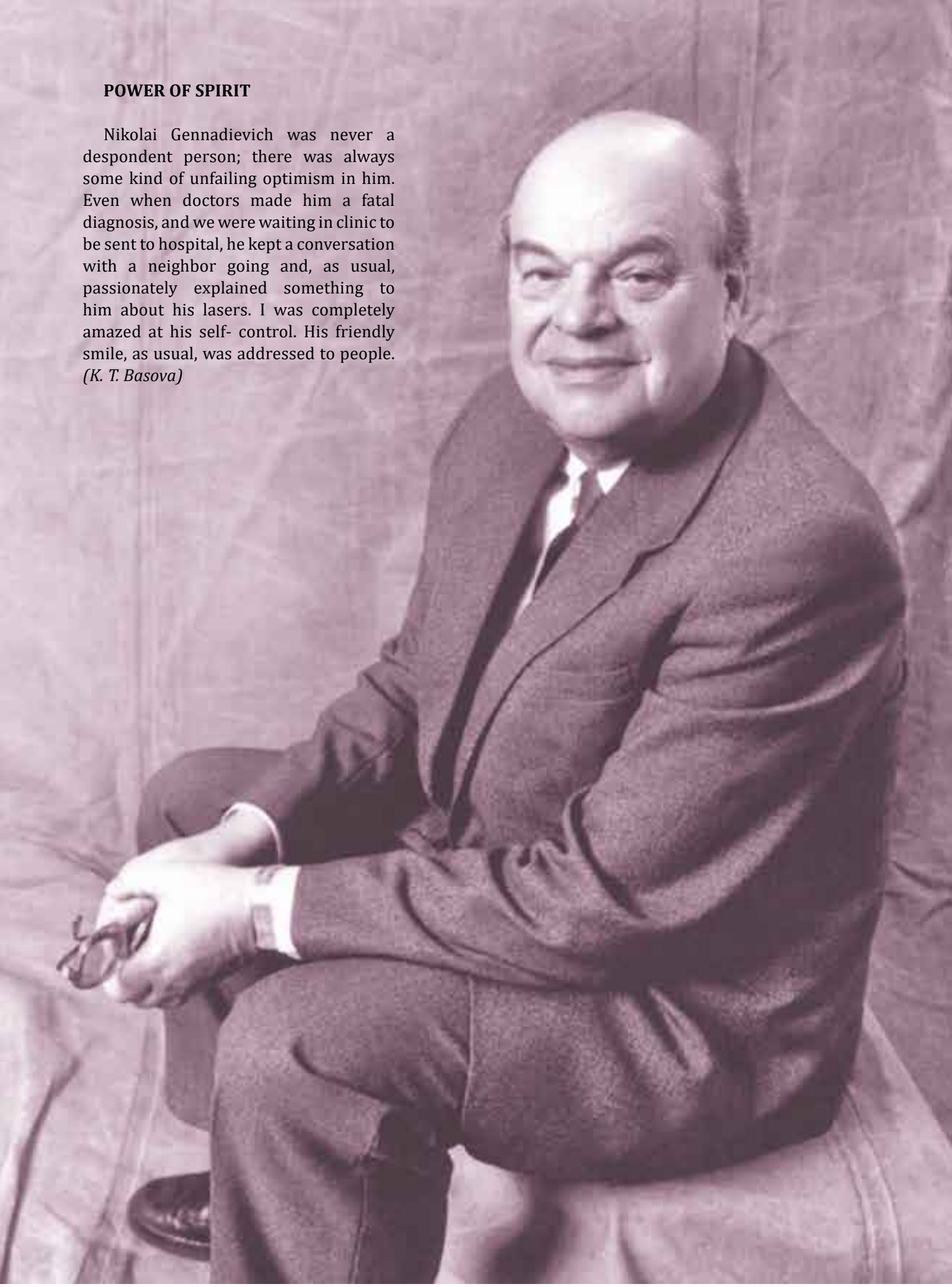
In Japan, 1992.

А. М. Прохоров поздравляет Н. Г. Басова с 70-летием. Слева направо: А. М. Прохоров, Л. В. Келдыш,?, Н. Г. Басов, В. А. Исаков. 1992 г.

A. M. Prokhorov congratulates N. G. Basov on the 70th anniversary. From left to right: A. M. Prokhorov, L. V. Keldysh,?, N. G. Basov, V. A. Isakov. 1992.

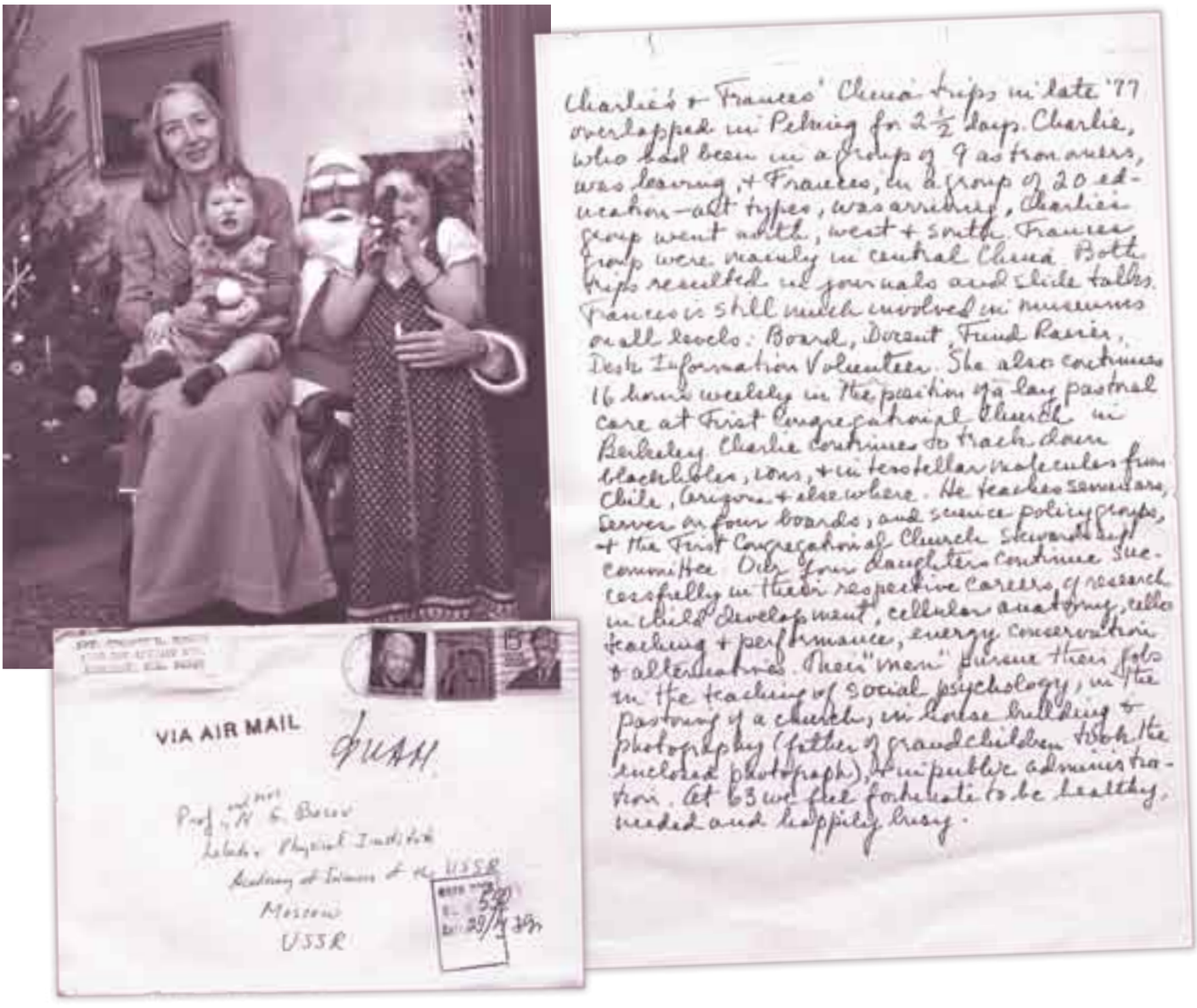
POWER OF SPIRIT

Nikolai Gennadievich was never a despondent person; there was always some kind of unfailing optimism in him. Even when doctors made him a fatal diagnosis, and we were waiting in clinic to be sent to hospital, he kept a conversation with a neighbor going and, as usual, passionately explained something to him about his lasers. I was completely amazed at his self- control. His friendly smile, as usual, was addressed to people. *(K. T. Basova)*



С Ч. Таунсом на юбилее Американского оптического общества. 1996 г.
With C. Townes at the jubilee of the Optical Society of America. 1996.

С супругой Ч. Таунса Фрэнсис Таунс во время встречи нобелевских лауреатов. 1991 г.
With the wife of Charles Townes, Francis Townes, during the meeting of Nobel laureates. 1991.



Письмо и фотография Н. Г. Басову от семьи Таунсов. С семьёй Чарльза Таунса Николая Геннадиевича связывали долгие годы дружбы.

A letter and a photograph to N. G. Basov from the Townes family. Nikolai Gennadievich was associated with the family of Charles Townes by friendship for many years.

В центре А. М. Прохоров и Н. Г. Басов. Слева внук Александр Прохоров, справа сын Дмитрий Басов.

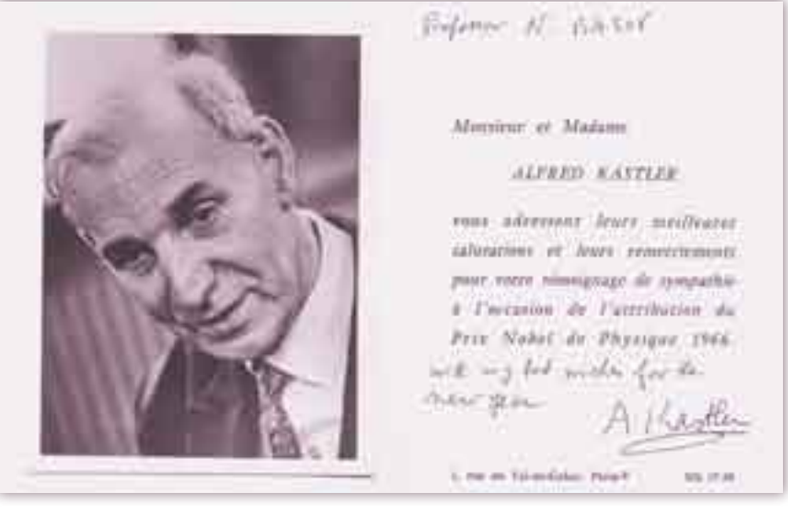
In the center: A. M. Prokhorov and N. G. Basov; grandson Alexander Prokhorov (left), son Dmitry Basov (right).

Памятники на могилах Н. Г. Басова (справа) и А. М. Прохорову (слева) на Новодевичьем кладбище в Москве.

Monuments on N. G. Basov (right) and A. M. Prokhorov (left) graves at the Novodevichy Cemetery in Moscow.

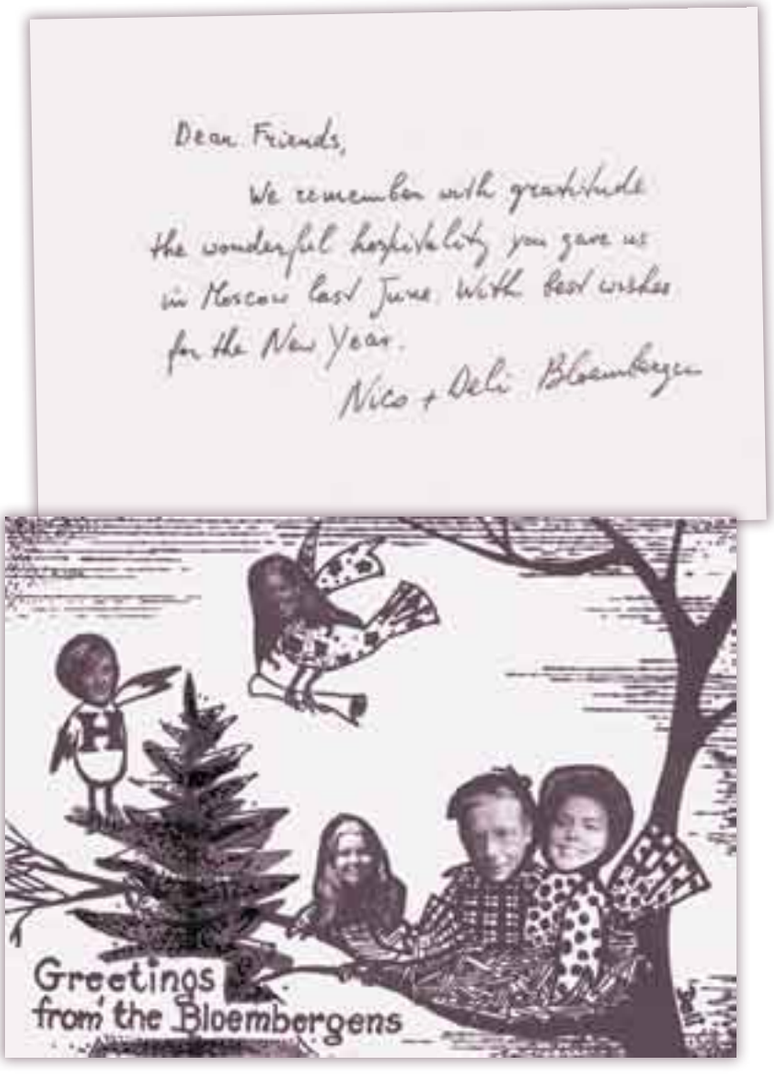
COMPANIONS IN THE FOUNDATION OF QUANTUM ELECTRONICS

<...> At the beginning of the 21st century, the outstanding Russian scientific tandem passed away with a little more than six months difference. First, on July 1, 2001, died the student – Basov. On January 8, 2002, died the teacher. Alexander Mikhailovich loved his talented student very much, treated him with great respect and grieved over the untimely death of his comrade-in-arms in the development of a new branch of physics they had created. And they lie close to each other at the Novodevichy Cemetery, just as they lived in one house in Kuntsevo district for several decades and worked side by side in their institutes in Vavilov Street. Although they are no longer with us, the science created by these Titans continues to keep the brain of many thousands of scientists and engineers around the world busy, so as to find new points of growth in many areas of knowledge. *(V. V. Apollonov)*



Поздравление от А. Кастлера.

Christmas card from A. Kastler.



Поздравление от семьи Н. Бломбергена.

Christmas card from N. Bloembergen family.

Памятник на могиле Н. Г. Басова на Новодевичьем кладбище.
Monument on N. G. Basov grave at the Novodevichy Cemetery.

Памятник Н. Г. Басову (скульптор Л. И. Баранов) в г. Усмани.

Monument to N. G. Basov (sculptor L. I. Baranov) in Usman.

Дань уважения. Марлан О. Скалли у галереи портретов ФИАНовских Нобелевских лауреатов.

A tribute to N. G.Basov. Marlan O. Scully at the Lebedev Institute at the gallery of portraits of FIAN's Nobel Prize Winners.

Золотая медаль имени Н. Г. Басова, присуждаемая Российской академией наук за выдающиеся работы в области физики.

Gold Medal named after N. G. Basov awarded by the Russian Academy of Sciences for outstanding research in the field of physics.

Памятник Н. Г. Басову в МИФИ от благодарных учеников. Скульптор Александр Миронов, спонсор – Андрей Новиков, выпускник Высшей школы физиков.

A monument to N. G. Basov at MEPhI from grateful graduates (the sculptor – Alexander Mironov, the sponsor – Andrey Novikov, the Higher School of Physicists graduate).

Открытие бюста Н. Г. Басова в ФИАНе. Слева направо: А. Н. Стародуб, О. Н. Крохин.

Opening of N. G. Basov's sculptural bust at the Lebedev Institute. From left to right: A. N. Starodub, O. N. Krokhin.

MONUMENT TO THE OUTSTANDING ALUMNUS

On November 23, 2017 National Research Nuclear University MEPhI celebrated its 75th anniversary, it was on this day that the Decree of the USSR Council of People's Commissars on the formation of the University was signed. To celebrate this significant event, the monument to the outstanding Russian scientist, academician, Nobel Prize Winner in physics, MEPhI graduate Nikolai Gennadievich Basov was unveiled in front of the main building of the University.

Recalling the years of joint work with N. G. Basov, Academician of the Russian Academy of Sciences O. N. Krokhin noted that Nikolai Gennadievich was a genius in the full sense of the word, both in a purely scientific sense – he was an exceptional scientist of a high level- and from the point of view of his perception of the world. According to Oleg Nikolaevich, the scientist perceived physics in a completely extraordinary way, he lived in science, and it was the most important thing for him: «Sometimes it was difficult to work with him, because he used to think at night. When we came to the Institute in the morning it turned out that he had already gone far ahead in solving the problem and began to set tasks for us, at best, from the middle, but sometimes beginning from the end».

Сведения о малой планете Басов. Data about the small planet Basov.

PLANET BASOV

A minor planet discovered by the astronomer of the Crimean Astro-physical Observatory N. S. Chernykh on the 8th of August, 1978 was named after N. G. Basov (3599).

N. G. BASOV QUANTUM RADIOPHYSICS DIVISION: FURTHER DEVELOPMENT OF BASOV'S IDEAS.

After the death of Nikolai Gennadievich Basov, the ideas laid down by him continue to develop in the Quantum Radiophysics Division of the Lebedev Physical Institute, which bears the name of its founder and grew out of the Laboratory of Quantum Radiophysics founded by him in 1963. The main areas of scientific topics of the N. G. Basov Quantum Radiophysics Division are currently as follows: laser physics, including new types of lasers and lasers generating ultrashort pulses, interaction of laser radiation with matter, nonlinear optics, laser plasma physics, laser fusion, optoelectronics, X-ray optics, nanophotonics, new laser technologies, applications of lasers in science, technology, medicine and microbiology. In 2022, the Division consists of 15 experimental laboratories and theoretical sectors, some of which are part of the Department of Laser Plasma and the recently established the Center for Laser and Nonlinear Optical Technologies, and has the following structure:

Center for Laser and Nonlinear Optical Technologies (Gas Lasers Lab, Laboratory of Femtosecond Nonlinear Optics, Laboratory of Laser Nanophysics and Biomedicine).

Department of Laser Plasma (Laboratory for the Effects of Laser Radiation, Laboratory for Plasma Diagnostics, Sector of High Energy Laser-Plasma Physics, Sector of the Theory of Interaction of Radiation with Matter, Sector of the Theory of Laser Plasma).

Injection Laser Laboratory.

Laboratory of Nonlinear Optical Phenomena.

Laboratory of optoelectronic processors.

Laboratory of ultrafast optoelectronics and information processing.

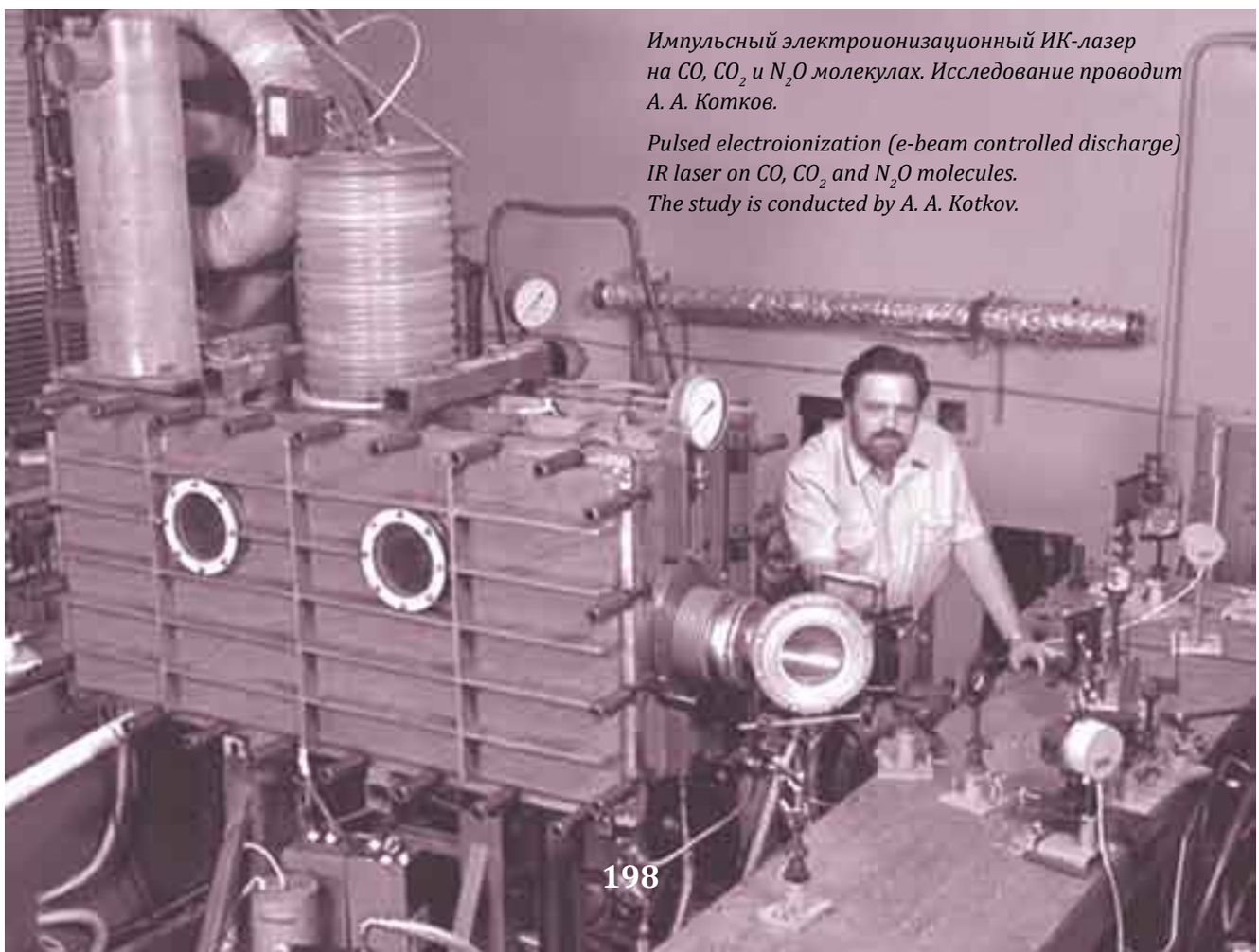
Molecular Photonics Laboratory.

Sector of Theoretical Radiophysics.

X-ray Optics Laboratory.

After the death of N. G. Basov, the N. G. Basov Quantum Radiophysics Division was headed by A. N. Starodub from 2001 till 2005, by O. N. Krokhin, from 2005 till 2010, by A. A. Ionin from 2010 till the present.

Since 2001, the N. G. Basov Quantum Radiophysics Division has been holding an annual competition of scientific works for the N. G. Basov Prize, and on December 14 – Nikolai Gennadievich birthday – holds the meeting «Basov Readings», where the winners of this competition are awarded, and leading scientists in the field of quantum electronics make presentations. *(A. A. Ionin)*



Импульсный электроионизационный ИК-лазер на CO, CO_2 и N_2O молекулах. Исследование проводит А. А. Котков.

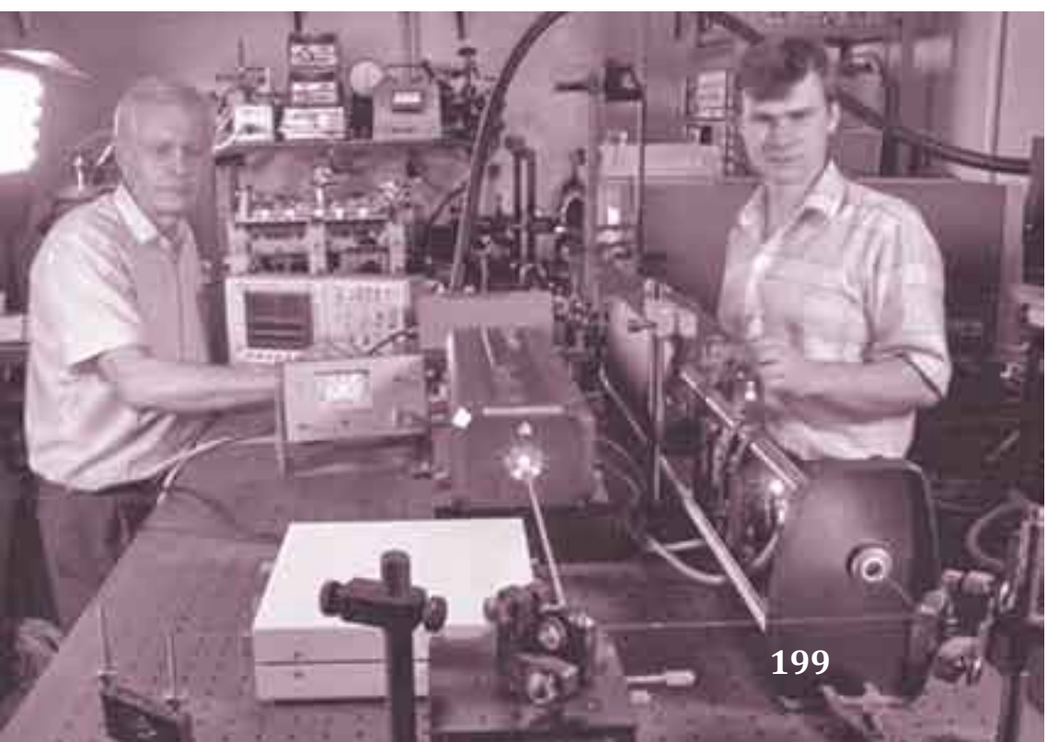
Pulsed electroionization (e-beam controlled discharge) IR laser on CO, CO_2 and N_2O molecules. The study is conducted by A. A. Kotkov.

Импульсный лазер на атомных переходах. Оптическую схему юстирует И. В. Холин.

A pulsed laser on atomic transitions of noble gases. The optical scheme is adjusted by I. V. Kholin.

Мощная лазерная установка МКГ-2. Исследование выполняет В. Ф. Ефимков.

MKG-2 – powerful quantum generator. The study is conducted by V. F. Efimkov



Фемтосекундная лазерная установка с широкополосным фотохимическим усилителем. Слева направо: Л. Д. Михеев, В. В. Мыславский.

A femtosecond laser facility based on broadband photochemical amplifier. Left to right: L. D. Mikheev, V. V. Mislavsky.

Обсуждение схемы записи волноводных голограмм. Слева направо: А. Ангервакс, С. С. Копенкин, Р. Окунь, А. Н. Путилин, А. Перевозникова.

Discussion of the waveguide hologram recording scheme. From left to right: A. Angervaks, R. Okun, S. S. Kopenkin, A. N. Putilin, F. Perevoznikova.

У высокопроизводительного вычислительного кластера. Сидит В. Ю. Быченков. Стоят (слева направо): С. Г. Бочкарёв, Д. А. Гожев, И. И. Метельский, О. Е. Вайс, А. В. Брантов

At a high-performance computing cluster. V. Yu. Bychenkov is ahead. Back left to right: S. G. Bochkarev, D. A. Gozhev, I. I. Metelskii, O. E. Vais, A. V. Brantov

Изучение генерации ТГц излучения филаментами УФ лазерного излучения. Слева направо: Л. В. Селезнёв, Г. Э. Ризаев, Д. В. Мокроусова, А. В. Корибут, Я. В. Грудцын, А. А. Рогашевский.

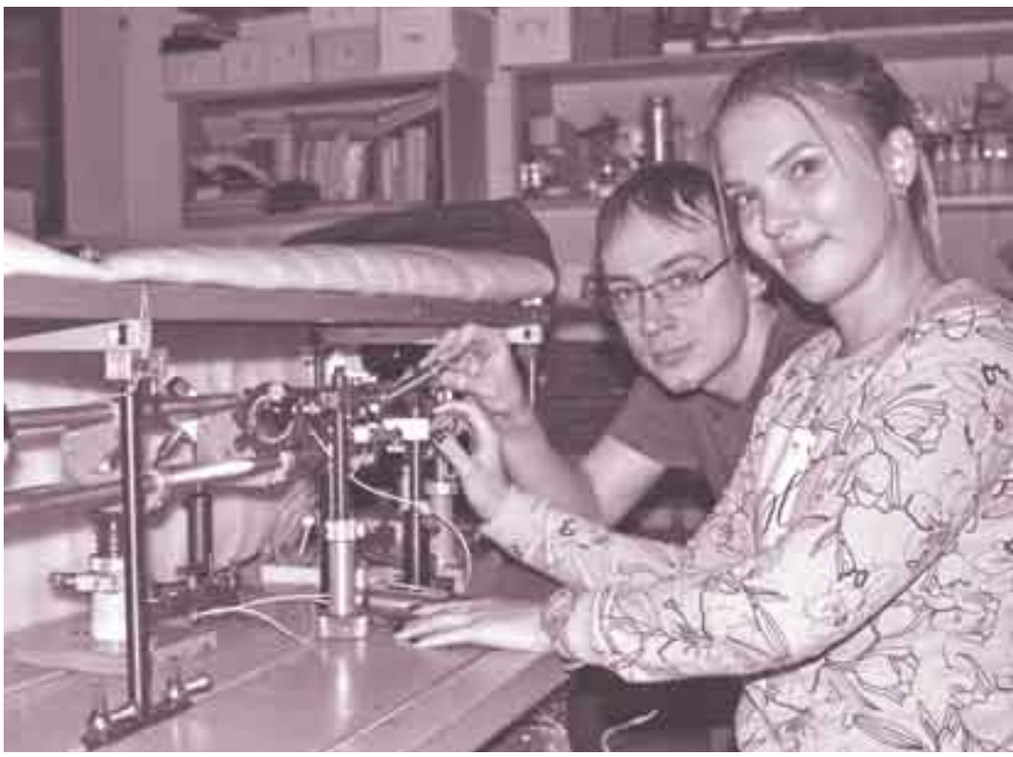
Study of generation of THz emission by UV laser radiation filaments. From left to right: L. V. Seleznev, G. E. Rizaev, D. V. Mokrousova, A. V. Koribut, Y. V. Grudtsyn, A. A. Rogashevsky

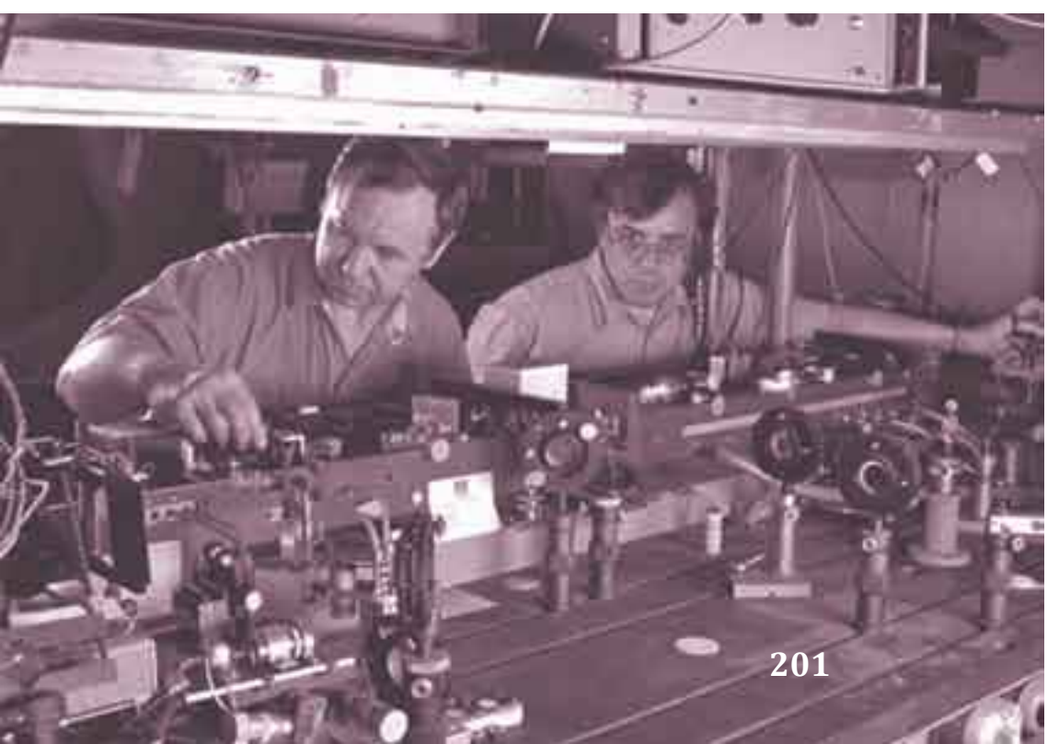
KrF лазерная установка «Гарпун». Слева направо: М. А. Рогулев, В. Д. Зворыкин, О. А. Левченко.

KrF laser installation «GARPUN». Left to right: M. A. Rogulev, V. D. Zvorykin, O. A. Levchenko.

Настройка интерферометра. Слева направо: В. А. Барбашов и А. Львова

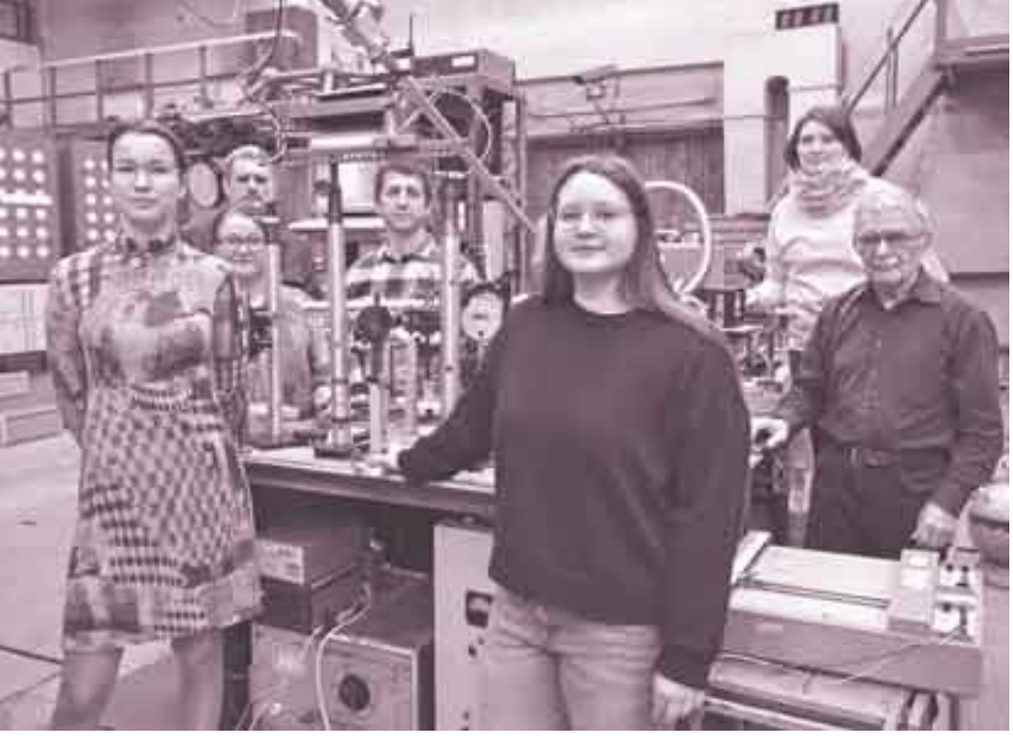
Setting up the interferometer. From left to right: W. A. Barbashov and A. L'vova





Экспериментальная установка по формированию и исследованию молекулярных пучков. В. А. Петухов и М. А. Семёнов.

Experimental setup for the production and investigation of jet-cooled molecules. Left to right: V. A. Petukhov and M. A. Semenov.

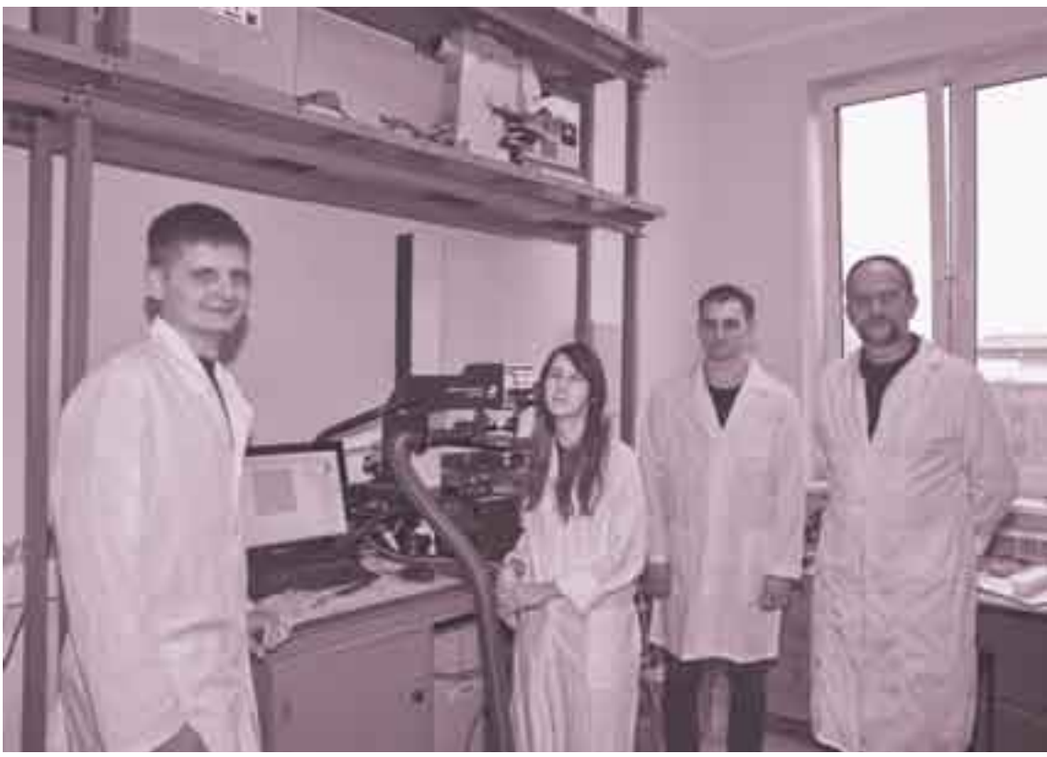


Вокруг измерительного комплекса лазерной установки «Канал-2». Слева направо: Д. М. Безверхняя, М. Н. Дмитриева, Т. Т. Кондратенко, А. Т. Саакян, А. В. Грицаева, А. А. Фроня, В. Н. Пузырёв.

Around the measuring complex of the Kanal-2 laser installation. From left to right: D. M. Bezverkhnyaya, A. V. Gritsaeva, M. N. Dmitrieva, T. T. Kondratenko, A. T. Sahakyan, A. A. Fronya, V. N. Puzyrev.

Лазерная фабрикация наночастиц. Слева направо: П. А. Данилов, И. Н. Сараева, Н. И. Буслеев, С. И. Кудряшов.

Laser fabrication of nanoparticles. From left to right: P. A. Danilov, I. N. Saraeva, N. I. Busleev, S. I. Kudryashov.



Эксперимент по конверсии частоты в среднем ИК диапазоне. Слева направо: А. Ю. Козлов, И. О. Киняевский, Ю. М. Климачев, А. М. Сагитова.

Frequency conversion experiment in the mid-IR range. From left to right: A. Yu. Kozlov, I. O. Kinyaevsky, Yu. M. Klimachev, A. M. Sagitova

A SCIENTIFIC REVOLUTION IS ON

Since ancient times, mankind has been looking for sources of new types of energy. Therefore, there are ample opportunities of activity in this field of knowledge for you, young people. Today, from one or several new fundamental ideas a huge number of new ideas, new approaches to solving problems that could only be dreamed of before, are born. There is a real revolution in many sciences at the same time. New scientific directions are emerging, research is deepening. Science puts forward new tasks that young scientists will solve. *(N. G. Basov)*

Формирование наноструктур фемтосекундным лазером. Слева направо: Н. А. Смирнов, А. А. Настулявичус, А. А. Ионин, А. Иванова.

Formation of nanostructures by a femtosecond laser. From left to right: N. A. Smirnov, A. A. Nastulyavichus, A. A. Ionin, A. Ivanova

Круглый стол, посвящённый 100-летию со дня рождения Н. Г. Басова, на 20-й Международной конференции «Оптика лазеров», Санкт-Петербург, 20-24 июня 2020 г.

The round-table dedicated to the Centenary of N. G. Basov's birth during the 20th International Conference Laser Optics (ICLO 2022), St.Petersburg, Russia, 20–24 June 2022.

LIFE EVENTS AND SCIENTIFIC ACTIVITY OF ACADEMICIAN N. G. BASOV

Nikolai Gennadievich Basov was born on **December 14, 1922** in the town of Usman, Tambov region.

1941, graduated from a high school (Voronezh);

1941–1945 (the Great Patriotic War)

1941–1942, student of the Kuibyshev Military-Medical Academy *(the city of Kuibyshev (now Samara – ed. remark))*;

1942–1943, cadet of the Kiev Military-Medical School *(evacuated to the city of Sverdlovsk (now Ekaterinburg – ed. remark))*;

1943, graduated from the Kiev Military-Medical School (city of Sverdlovsk), received the rank of a lieutenant of medical service, sent to the chemical-defense battalion;

1945 (January-May), service in the Red Army (1st Ukrainian Front);

1945, awarded the medal «For heroic labor during the great patriotic war 1941–1945»;

1946–1950, student of engineering-physics faculty of the Moscow Mechanical Institute (since 1953 – Moscow Engineering Physics Institute MEPhI);

1948–1963, laboratory assistant, engineer (1953), junior (1954), senior (1956) researcher; since 1959 – head of the molecular oscillators sector of the FIAN Oscillations laboratory;

1950–1953, postgraduate student of the Moscow Mechanical Institute (since 1953 – MEPhI);

1950, marriage to Kseniya Tikhonovna Nazarova; joined the communist party of the Soviet Union;

1954, degree of Candidate of Sciences in Math and Physics (PhD) for the thesis «Determination of nuclear moments by radio-spectroscopic method»;

1957, degree of Doctor of Sciences in Math and Physics for the thesis «Molecular oscillator»;

1958, Deputy Director of FIAN;

1959, Lenin Prize for the development of a new principle of generation and amplification of radio-waves (development of molecular oscillators and amplifiers); participated in the 1st International Quantum Electronics conference (USA), made a report on semiconductor quantum oscillators and amplifiers;

1958–1991, member, since 1964 deputy chairman, 1969, chairman of the physics section and member of Plenum, since 1989 member of the physics section of the USSR Committee on Lenin and State Prizes in science and technology under the USSR Council of Ministers;

1958–1961, member of the Oktyabrsky district CPSU committee, Moscow;

1961, took part in the 2nd International Conference on Quantum Electronics, report on «Lasers on indirect transitions in semiconductors»;

1959–1963, delegate of the Moscow City Council;

1962, elected a corresponding member of the USSR Academy of Sciences;

– visit to the USA for the Meeting of the American Physical Society, presentation on «Q-switched lasers»;

– visit to Germany for signing the scientific-technical Agreement between USSR Academy of Sciences and Max Planck Society, as a head of the Soviet delegation;

1960–1964, member of the Editorial-Publishing Council of the USSR Academy of Sciences;

1963, visit to France for the Third International Conference on Quantum Electronics, report on «Laser thermonuclear fusion»;

– visit to Japan, giving lectures at the scientific centers and companies;

1963, head of the newly organized Quantum Radiophysics Laboratory of FIAN;

1968–1982, head of the Division «B» of FIAN; since 1986, head of department, since 1989, director of the Quantum Radiophysics Division of FIAN;

– Professor of the Moscow Engineering-Physics Institute (MEPhI);

1975, member of the Plenum of the Higher Attestation Commission under the USSR Council of Ministers;

1964, awarded the Nobel Prize in Physics for fundamental research in the field of quantum electronics, which led to the creation of lasers and masers;

– visit to Sweden, giving Nobel lecture on semiconductor quantum oscillators and reports at the leading research centers of Sweden; visit to France for the International Congress on Semiconductor Physics, report on «E-beam pumped semiconductor lasers;

– visit to Bulgaria, giving lectures at the Institute of Electronics of the Bulgarian Academy of Sciences;

1965, visit to Finland for the World Peace Congress;

– visit to the USA for the International Conference on «Physical problems of quantum electronics»;

1965–2001, member: Soviet Peace Defense Committee, World Peace Council;

1966, full member of the USSR Academy of Sciences;

– visit to USA for the IV International Conference on Quantum Electronics; proposed possibility of using e-beam pumping for excimer lasers;

1967, awarded the Order of Lenin for the development of Soviet science and the application

of scientific achievements in the national economy;

– elected a foreign member of the German Academy Sciences in Berlin;

– visit to Hungary for the World Peace Council Meeting;

– Chairman of the Komsomol central committee commission on the Lenin Komsomol awards in the field of science;

1967–1990, editor-in-chief of the «Priroda» (Nature) journal;

1967–2001, member, since 1990, councilor of the USSR Academy of Sciences (now RAS) Presidium;

1968, visit to the USA for the Vth International Conference on Quantum Electronics, report on observation of thermonuclear neutrons in laser plasma;

– visit to the USA for the Gordon Conference on Nonlinear Optics;

1969, awarded: Hero of Socialist Labor, Order of Lenin, «Hammer and Sickle» gold medal for great achievements in the development of Soviet science;

– visit to Italy for signing an agreement on scientific and technical collaboration between USSR Academy of Sciences and the National Scientific Council of Italy;

– visit to England for the United Conference on Lasers and Optoelectronics;

– visit to France for a Conference on Laser Plasma Physics;

– visit to the GDR, acquaintance with the research reform in the GDR;

1969–2001, chairman of the Higher School of Physicists (MEPhI) Organizing Commission;

1970, awarded: «For the heroic labor» jubilee medal to the Centenary of Lenin's birth;

– visit to the GDR Academy of Sciences for the 70th anniversary of the M. Planck's quantum discovery; delivered a report;

– visit to the GDR for the Ist International Conference on Lasers and their Applications and the 4th Meeting of experts of the USSR and GDR Academies of Sciences on collaboration in the field of quantum electronics;

1971, visit to England for the International Conference on High-Power Lasers» and visits to quantum electronics labs;

– elected a member of the German Academy of Naturalists «Leopoldina»;

– visit to Hungary and England for the World Peace Council meeting;

1971–2001, editor-in-chief of the Soviet Journal of «Quantum Electronics»;

1972, awarded the Order of Lenin for the development of Soviet science and training of scientific personnel, and on the occasion of his fiftieth birthday; honorary doctor of J. Dombrowski military-technical Academy (Poland); foreign member of the Optical Society of America; honorary member of the Bulgarian physical society;

– visit to Canada for the 7th International Conference on Quantum Electronics;

– visit to the USA, lectures at the leading research centers;

– visit to France for the European Conference on Laser Interaction with Matter;

1973, appointed: Director of P. N. Lebedev Physical Institute of the USSR Academy of Sciences (FIAN);

1973, visit to the GDR for the 2nd International Conference on «Lasers and their Applications», and the VIth Meeting of experts of the USSR and GDR Academies of Sciences on quantum electronics;

1974, visit to France giving lectures at the leading scientific centers of France;

– elected: foreign member of the Bulgarian Academy Sciences; distinguished member of the Optical Society of America; honorary Doctor of F. Schiller University, Jena (GDR);

1974–1981, member of the Moscow CPSU City Committee;

1974–1989, member of the USSR Supreme Soviet;

1974–2001, editor-in-chief of «Trudy FIAN» Journal (Proc. of FIAN);

1975, awarded: the Order of Lenin for the development of Soviet science and in connection with the 250th anniversary of the USSR Academy of Sciences, the jubilee medal «Thirty years of the Great Patriotic War Victory 1941–1945»;

– the gold medal «For services to science and humanity» of the Czechoslovak Academy of Sciences;

– elected: foreign member of the Royal Swedish Academy of Engineering Sciences; honorary doctor of the Prague Polytechnic Institute;

– visit to Sweden for the 75th anniversary of the Nobel Prize Committee;

– visit to England for the Congress of World Federation of Scientists (WFS);

1975–2001, editor-in-chief of «Bulletin of Lebedev Physics Institute»; member of the Interdepartmental scientific council on measurement problems,

1976, visit to England for the XI General Assembly of WFS;

– visit to the Netherlands for the IX International Conference on Quantum Electronics; report;

– visit to France for the IX European Conference on Laser Interaction with Matter;

1976, deputy chairman of the executive council, since 1983 vice-president, since 1990 honorary member of WFS;

– head of the all-Union School «Actual problems of physics» (Rostov);

1977, elected: foreign member of the Polish Academy of sciences; honorary member of the Mark Twain Society (USA); foreign member of the Czechoslovak Academy of Sciences;

– awarded: the A. Volta Gold medal, University of Pavia (Italy); honorary doctor of Pavia University;

– visit to the USA for the International Scientific Forum on «Acceptable future of nuclear energy for the world»; lectures at the american scientific centers;

– visit to the GDR, as the head of the Soviet delegation, for the III International Conference on «Lasers and their Applications» and participation in the meeting of experts of the USSR and GDR Academies of Sciences in the field of quantum electronics;

– lecturing at the scientific centers of Italy;

1977–2001, deputy chairman, since 1978 – chairman, since 1990 – honorary chairman of the board of the all-union «Znanie»(Knowledge) Society;

1978, awarded the jubilee medal «100th anniversary of the liberation of Bulgaria from the Ottoman yoke»;

– visit to England for the International Semiconductor Physics Conference; 1978–2001, member of the expert commission for awarding the M. V. Lomonosov prize of the USSR Academy of Sciences (now RAS);

1979, visit to Sweden as the head of the soviet delegation to the «Days of Soviet science and technology in Sweden», giving lectures at leading scientific centers of Sweden;

– visit to England for participation in the WFS Executive Council;

– visit to the GDR for a ceremonial meeting of the GDR Academy of Sciences dedicated to the 100th anniversary of A. Einstein birth, report on «Induced radiation»;

– visit to Germany for the meeting of the Nobel laureates-physicists, delivered a report;

1979–2001, member of the Scientific Council Bureau on studying the peace and disarmament problems of the USSR Academy of Sciences, SCST and the Soviet Peace Committee;

– member of the Interdepartmental Scientific and Technical council on problems of laser technology at the State Committee on Science and Technology (SCST) and the Presidium of the USSR Academy of Sciences;

– member of the Nuclear Physics Division of the American physical society; 1980 – honorary member of the «Urania» Society (GDR);

– member of the European Academy of Sciences, Arts and Literature (Paris);

– visit to the USA for the International Conference «Lasers-80»;

1980–2001, editor-in-chief of the Journal of Soviet Laser Research (Moscow);

– member: editorial board of the international yearbook «Science and Humanity»; Scientific Council on the complex problem «Philosophical and social problems of science and technology» at the USSR Presidium of the Academy of Sciences (now RAS); Council for Communications between the USSR Academy of Sciences and Higher Education, under Presidium of the USSR Academy of Sciences and the Ministry of Higher and Secondary education of the USSR;

1981, awarded: the Order of Cyril and Methodius I degree (Presidium of the People's Assembly of the People's Republic of Bulgaria);

– elected: an honorary member of the TIT society (Hungary).

– visit to West Berlin for the International Congress on Luminescence, report;

– visit to the USA for the International Conference «Lasers-81» and research centers on quantum electronics;

– visit to the GDR, as the head of the Soviet delegation, to the IV International Conference «Lasers and their Applications» and participation in the X Meeting of Experts of the USSR and GDR Academies of Sciences in the field of quantum electronics;

– Delegate of the XXVI Congress of the CPSU;

1982, awarded (for the second time) the title of Hero of Socialist Labor, the Order of Lenin and the Golden Star «Hammer and Sickle» for outstanding merits in the development of physics, the training of scientific personnel, and in connection with the sixtieth birthday;

– visit to France, Spain for a meeting of WFS Executive Council;

– visit to England for the Days of Soviet Science in England; reports at general meetings of the London and Edinburgh Royal Societies;

– visit to Germany for the XII International Conference on Quantum Electronics;

1982–1989, member of the Presidium of the USSR Supreme Council;

– deputy Chairman of the USSR Parliamentary Section on peace and disarmament;

1983, visit to England for the XVI European Conference on Laser Interaction with Matter;

– visit to France for the XIII Session General Assembly of the WFS (elected Vice President of WFS), the meeting of Nobel laureates in Paris; awarded the medal of the Sorbonne University, the Grand gold medal of Paris, the medal of the Ministry of Culture of France,

1984, honorary doctor of the Madrid Polytechnic University;

– visit to the GDR, as the head of the Soviet delegation, for the XII meeting of experts of the USSR and GDR Academies of Sciences on cooperation in the field of quantum electronics;

– visit to Japan for the International Symposium in memory of Professor U. Nishina; the memorial lecture;

1985, awarded: the Order of the Great Patriotic War II degree, the jubilee medal «Forty Years of the Great Patriotic War Victory 1941–1945»;

– visit to Spain for giving lectures at the Madrid Polytechnic University and other scientific centers of Spain;

– visit to the GDR as the head of the Soviet delegation, for the V International Conference on «Lasers and their Applications»;

1986, awarded: the Commandor's Cross of the Order of «Merit» (Poland); distinguished Member of the Indian National Academy of Sciences; the E. Henkel Gold Medal of the «Urania» Society (GDR), the Kalinga Prize for popularization of science and for scientific and educational activity (UNESCO);

– visit to Sweden for the VI General Conference European Physical Society on Physics of Condensed Matter;

– visit to India for the Jubilee meeting in memory of I. Gandhi; report;

– visit to Poland as the head of the USSR Academy of Sciences delegation, for participation in the Commission on cooperation between the USSR and Polish Academies of Sciences, elected chairman of soviet part of the Commission;

– visit to Germany within the framework of scientific and technical agreement between FIAN and the Leybold-Hereus Company;

– Delegate of the XXVII CPSU Congress;

1987, visit to the GDR for the XIV meeting of experts of the USSR and GDR Academies of Sciences in the field of quantum electronics;

– visit to the Netherlands attending the preparatory committee for the II Congress of Nobel Prize Laureates and visiting scientific centers of the Netherlands;

– visit to the USA, getting acquainted with the laser thermonuclear fusion research of American scientists;

– visit to Japan for giving lectures and getting acquainted with the research of Japanese scientists on laser thermonuclear fusion;

1988, honorary doctor of Karl-Marx-Stadt Technical University (GDR).

– awarded the gold medal «For achievements in the development of science» of the Slovak Academy of Sciences;

– visit to France for a meeting the UNESCO Secretariat; report, appointed Adviser to the UNESCO Secretariat on the physics programs;

1989, awarded the USSR State Prize for the Studies on Electroionization Synthesis of Chemical Compounds;

– elected an honorary member of the International Academy of Sciences (Munich);

– visit to Sweden for the Jubilee session of the Royal Swedish Academy of Engineering Sciences, dedicated to the 70th anniversary of the Academy;

– visit to the GDR for giving lectures at the Karl-Marx-Stadt Technical University;

– visit to India to the 100th anniversary of the birth of D. Nehru; delivered a report;

1990, award: the M. V. Lomonosov Gold Medal of the USSR Academy of Sciences for outstanding achievements in the field of physics;

– visit to Germany for the XX European Conference on Laser Interaction with Matter;

– visit to the USA for the International Conference on Lasers and Electro-optics;

– visit to France for participation in work of the UNESCO Secretariat;

1991, awarded the Edward Teller Medal for Achievements in the field of thermonuclear fusion;

– elected an honorary member of the European Academy of Sciences and Arts (Salzburg);

– visit to the USA for the X International Conference on Laser Interaction and the Related Plasma Phenomena; made a report on the strategy and development of inertial thermonuclear fusion;

– visit to Germany for the meeting of the Nobel laureates-physicists; delivered a report;

– visit to Austria for a meeting with the Director General of the IAEA;

– visit to Japan for the IAEA Technical Committee on drivers for inertial fusion; delivered a report;

– visit to Sweden for the Jubilee Conference on the 90th anniversary of the first Nobel prize; delivered a report;

1991–2001, member: Expert Council under Chairman of the RF Government;

– Russian Optical Society;

1992, honorary member of the Natural Sciences Academy of the Russian Federation;

– visit to France for a meeting of UNESCO Secretariat in frames of the FIAN-UNESCO collaboration program and consultations on partnership between the Russian Academy of Sciences and UNESCO in the field of physical research;

– visit to Japan for the II International Conference on laser processing of materials; lectures at scientific centers of Japan;

1993, member of the Academy of Creativity (Moscow).

1994, awarded the Order of the Great Patriotic War II degree;

1997, awarded the Order of «Services to the Fatherland» II degree, for great personal contribution to the development of science and training of highly qualified personnel;

2000, awarded the RF President Prize in the field of education in 2000 for the foundation and realization of the «Higher School of Physicists MEPhI – FIAN» project;

– awarded the medal «For Strengthening of military commonwealth», For merits in strengthening the defense of the Russian Federation, the development of the armed forces of the Russian Federation and military cooperation with friendly states.

On **July 1, 2001** Nikolai Gennadievich Basov passed away. He was buried at the Novodevichy cemetery in Moscow.

LIST OF USED LITERATURE

1. Photos and documents:
   – N. G. Basov's fund in the RAS Archive;
   – FIAN history office;
   – personal archive of K. T. Basova;
   – archival documents of the FIAN Quantum Radiophysics Division;
2. Nobel lectures. Physics. 1963–1970 – World Scientific.
3. N. G. Basov. About quantum electronics. Articles and reports, «Nauka» Publishing House, 1987.
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5. Nikolai Gennadievich Basov. Materials to the biobibliography of scientists. – Moscow: Nauka, 1993.
6. Physics Today 55, 10, 68 (2002).
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8. Quantum Electronics, 32, No. 12, 2002.
9. Quantum Electronics, 12, No. 3, 1985.
10. Science and humanity 1995–1997. – M.: «Znanie» Publishers, 1997.
11. Our house on Zvenigorodskaya street. – «Nauka» Publishers, 2009.
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18. P. V. Zarubin. Laser weapon, is it myth or reality?/Vladimir. 2009.
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22. Science and Life, No. 11, 2007.
23. N. G. Basov. Quantum electronics at the P. N. Lebedev Physical Institute, USSR Academy of Sciences. – UFN, vol. 148, no. 2, 1986
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27. Quantum Electronics, 47, No. 12, 2017.
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29. Research on history of physics and mechanics, 2019–2020, ed. Vl. P. Vizgin, Yanus-K, Moscow, 2021.
30. P. V. Zarubin, «High Energy Lasers and Laser-Based Systems in the USSR», Directed Energy Systems Symposium, Monterey, CA, USA, 12–16 April 2010.
31. Interview of N. G. Basov to Prof. A. Guenther, 14 Sept 1984, AIP/American Institute of Physics, https://www.aip.org/history-programs/niels-bohr-library/oral-histories/4495

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