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A word about Nikolai Gennadievich Basov

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Nikolai Gennadievich Basov – one of the founders of quantum electronics (the Nobel Prize in Physics 1964 was awarded jointly to Nikolai Gennadievich Basov, Aleksandr Mikhailovich Prokhorov and Charles Hard Townes, 'for fundamental work in the field of quantum electronics, which has led to the construction of oscillators and amplifiers based on the maser-laser principle') – would have been 90 on 14 December 2012. In our time, quantum electronics is associated mainly with lasers, the variety of which, as well as their applications, is extremely high. Also large is the number of scientists and engineers working in this field.

N.G. Basov was the founder and head of the scientific school highly recognised throughout the world. Moreover, he worked with great energy and zeal until his last day.

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 radio-frequency 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. These objectives were reflected in the first journal publications of N.G. Basov and A.M. Prokhorov (Zh. Eksp. Teor. Fiz., Vol 27, p. 431, 1954) and the group of Ch. Townes at Columbia University (Phys. Rev., Vol. 93, p. 282, 1954).

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 understant 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 generator (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 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.

N.G. Basov founded in his beloved Moscow Engineering Physics Institute (now National Research Nuclear University 'MEPhI'), where he studied in the post-war years, the 'Higher School of Physicists', which now bears his name. The school has students from many regions of our country.

He founded the journal 'Quantum Electronics' and was the chief editor of such journals as 'Priroda' (Nature) and 'Bulletin of the Lebedev Physics Institute'.

Of course, it is impossible to enumerate all that he has left us, his disciples and followers, as the inheritance of his very active and fruitful creative life. He was a truly unique person and scientist, and the results of his activity belong to the entire mankind.

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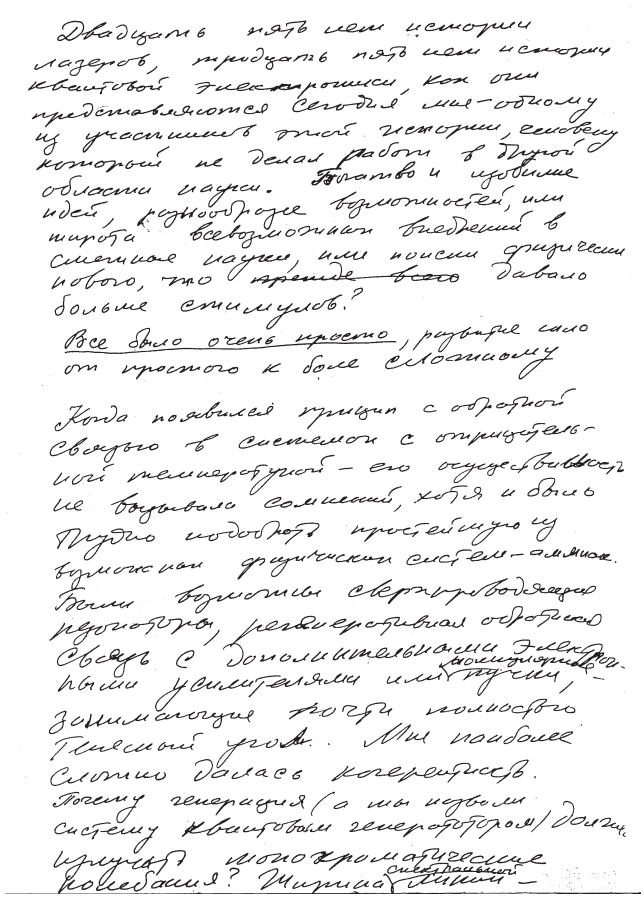
The editorial staff of 'Quantum Electronics' offers the readers of the journal an excerpt from N.G. Basov's memoirs never published before.*



Двадцать пять лет истории лазеров, тридцать пять лет истории квантовой электроники, как они представляются сегодня мне – одному из участников этой истории, единому, который не делал работу в другой области науки. Богатство и изобилие идей, разнообразие возможностей, или широта всевозможных внедрений в смежные науки, или поиски физически нового, что прежде всего давало больше стимулов?

Все было очень просто, развитие шло от простого к более сложному.

Когда появился принцип с обратной связью в системах с отрицательной температурой – его осуществимость не вызывала сомнений, хотя и было трудно подобрать простейшую из возможных физических систем – аммиак. Были возможны сверхпроводящие резонаторы, регенеративная обратная связь с дополнительными электронными усилителями или молекулярными пучками, занимающими почти полностью телесный угол. Мы наиболее сильно делали когерентность. Почему генерация (о нем первой системе квантовым генератором) должна иметь монохроматические колебания? Ширина спектральной линии –

Twenty-five years of the history of lasers, thirty-five years of the history of quantum electronics, how do they appear today to me – one of the participants of this history, a man who did not work in any other field of science. 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. The first person I was able to explain this was, apparently, my friend B.D. Osipov.

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…

Nikolai Gennadievich Basov and his wife Kseniya Tikhonovna (Khosta, 1966)

* The autograph manuscript is courtesy of Kseniya Tikhonovna Basova..