

## Andrey Viktorovich Gaponov-Grekhov (on his 90th birthday)

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June 7, 2016 was the 90th birthday of an outstanding Russian scientist and a prominent organizer of Russian science — Academician Andrey Viktorovich Gaponov-Grekhov.

A V's first steps in science were associated with the development of the theory of electromagnetic emitters in distributed resonance systems. He carried out this work when he was a student at Gorky State University under the guidance of M L Levin. In 1949, A V graduated from the university and entered the postgraduate course under A A Andronov, who was one of the founders of the now well-known Nizhny Novgorod (Gorky) scientific school of radio physics. The series of studies on the general theory of electromechanical systems appeared to be so significant that, having defended his Candidate of Sciences thesis in 1955, A V Gaponov-Grekhov received the degree of Doctor of Sciences in Phys. & Math.

The research on wave dynamics in nonlinear media and the theory of oscillations in distributed systems carried out by A V together with his disciples in the late 1950s resulted in the discovery of shock electromagnetic waves, laying the foundation of one of the key directions of modern physics, namely, nonlinear dynamics of distributed systems. This work stimulated to a considerable extent the development of such disciplines at the Nizhny Novgorod school of radio physics as nonlinear optics, nonlinear acoustics, dynamical chaos, and self-organization in complex dynamical systems. In all these areas of nonlinear physics, the Nizhny Novgorod school of radio physics now occupies the leading positions.

One of A V's most brilliant scientific achievements that disclosed in full measure his talent as an outstanding scientist and organizer of science was the formulation in 1958–1961 of the theory of stimulated emission of classic nonlinear oscillators, the formulation on this basis of a new principle of generation and amplification of electromagnetic waves, and implementation of this principle in electronic devices. In this work, A V managed to realize almost simultaneously the formulation of the theory, the statement of the experiment, and the design of a new type of devices, namely, cyclotron resonance masers (CRMs). These devices, later called gyrotrons, proved to be beyond comparison as the most powerful generators and amplifiers of coherent radiation in the centimeter, millimeter, and submillimeter ranges. In succeeding years, A V's scientific interest was supplemented with relativistic electronics. These studies also led to the creation of a whole class of powerful microwave relativistic devices capable of generating nanosecond gigawatt peak-power pulses. The created high-power microwave radiation sources found application in setups of controlled thermonuclear fusion, high-power radars, and technological, in particular, plasma-chemical processes, and the range of their application is constantly being extended. The works on the



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creation and exploitation of high-power microwave radiation sources implemented under the guidance of A V were thrice awarded the State Prizes of the USSR and Russian Federation.

The role of prominent scientists in the development of science is, as rule, not limited to the results obtained by them personally or their disciples. As has already been mentioned, A V belongs to the group of outstanding organizers of science. Perhaps A V's main merit in this area is the foundation in 1977 of the Institute of Applied Physics of the USSR Academy of Sciences, where he was Director for over a quarter of a century. Under his guidance, the Institute of Applied Physics (IAP) became within a short time one of the leading physical centers in the country, where the fundamental and applied wide-profile studies are successfully combined. IAP occupies a strong position in the field of plasma physics, high-power electronics, hydrophysics and hydroacoustics, quantum radio physics and nonlinear optics, and millimeter and submillimeter wave physics. The large-scale complex works accomplished at IAP RAS won worldwide recognition and was awarded more than 30 different prizes, including the Lenin Prize, 14 State Prizes, five prizes of the USSR and RF Governments, and a whole number of other prizes, including international ones.

Guiding a number of research works on defense themes and being Chair of the Academic Council of RAS on the complex problem ‘Hydrophysics’ in 1987–2012, A V made a significant contribution to reinforcement of the defensive potential of Russia in areas concerning the solution of scientific and applied problems of the navy. The study of the low-frequency range of sound waves as the ‘working instrument’ of active ocean diagnostics in vast water areas began, in fact, on his initiative. In the mid-1980s, demonstrational natural experiments performed under A V’s scientific guidance convincingly showed the potentialities of the distant diagnostics of the underwater medium at distances of up to 1000 km. The scientific and technological basis was laid of the design of high-power low-frequency coherent acoustic emitters without which no serious experimental studies in the field of ‘distant’ ocean acoustics are possible. The hydroacoustic emitters designed at IAP RAS have up to now been uneclipsed in their characteristics and have been used successfully in numerous natural experiments. For instance, such emitters were used to realize the unique Russian–American TAP and ACOUS projects on the propagation of low-frequency (in the range of  $\sim 20$  Hz) signals on stationary transarctic paths that seem to be an important step in realizing the idea of global oceanic climate thermometry by means of low-frequency acoustics.

World-level results were also obtained in the area of quantum electronics, laser physics, and nonlinear optics under the guidance of A V. For example, the first ruby laser in the USSR was created in 1962. In the period of the heady development of quantum electronics (1965–1990), the work of researchers from the Institute determined to a considerable extent the advanced level of the development of this branch of science. This is evidenced by two State Prizes, the Prize of the Council of Ministers of the USSR, and two Prizes of the RF Government received by researchers at the Institute engaged in these themes. In the late 1990s, a terawatt femtosecond laser complex, the first in Russia, was created at IAP RAS; then it was a petawatt-level facility, and now a multipetawatt-level laser facility is being created on this basis. These results made it possible, in fact, to cope with the backwardness of Russian science compared to the world level in the area of femtosecond optics and stimulated the development in Russia of a new scientific direction—the physics of superstrong electromagnetic fields and their interaction with matter. One of the most important programs of fundamental research of the RAS Presidium, “Femtosecond optics and the physics of superstrong laser fields” (the initial name), was originated on A V’s initiative. Studies within the framework of this program have been carried out to date. The program coordinates the activity of more than 20 scientific institutes in a strategically important area of contemporary physics—the creation and employment of sources of supershort-pulse laser radiation for scientific, industrial, informational, biomedical, and military-technical applications.

The recognition of A V’s achievements in solving the fundamental and applied problems of modern physics and economic and defense issues was his election as Corresponding Member of the USSR Academy of Sciences (1964) and Full Member of the USSR Academy of Sciences (1968). He received three State Prizes (1967, 1983, 2003), the Demidov Prize (1995), the highest award of the RAS—the M V Lomonosov Large Gold Medal (2000), high state awards such as the title of Hero of Socialist Labor (1986), two Orders of Lenin (1975, 1986), the Order of the October

Revolution (1981), and the orders For Merit to the Fatherland of 3rd and 2nd degrees (1999 and 2006).

One of the main priorities for A V himself and the Institute founded by him is work with scientific youth. From the first years of the existence of IAP RAS, a system of continual training of young scientists has been developed. It includes the basic physico-mathematical school, basic faculty and sub-faculties at Nizhny Novgorod State University, an institute of trainees, and the postgraduate course. All these key components of professional training and adaptation of young scientists were consolidated at the Scientific and Educational Center of IAP RAS, specially founded in 2001, which was then supplemented with specialized school classes in the field of physics and biology, to which pupils from schools of the whole town are selected and taught in special programs. The high efficiency of the youth training system carried out at IAP RAS is evidenced by the fact that within sixteen years of its foundation, 18 cycles of work done at the Institute by young scientists were awarded RAS medals with prizes for young scientists in physics, earth sciences, and the scientific instrument-making industry.

Speaking of the attention A V has paid to work with scientific youth, one cannot but emphasize the special role of Gorky (Nizhny Novgorod) scientific schools in nonlinear waves, which continually functioned for many years under his guidance from 1972 to 1989 with the participation of leading Soviet specialists and brilliant young scientists who only began working in this interdisciplinary area. In the 2000s, such schools again began working continually, and in 2016 it was already the 17th school of ‘nonlinear waves’. For many young participants, the tradition of involving many post-graduates and even students (and not only from Nizhny Novgorod) meant these scientific schools actually became schools of ‘nonlinear knowledge’ gained first hand.

The principles of work and the selection rules laid down by A V from the first years of IAP’s work do not only hold at present but are being further developed in response to the challenges of time. As before, the Institute occupies leading positions in many areas of modern physics, large-scale fundamental research and applied work are being carried out as before, and, as before, many talented young scientists work there.

One cannot help noting the multifaceted and important scientific organizational activity of A V outside the Institute. It is not only his above-mentioned work on the Academic Council of RAS on Hydrophysics (which began when this council was headed by the President of the USSR Academy of Sciences A P Aleksandrov), where he has been working up to now as a research supervisor of the Council, it is also his participation in many other academic, and not only academic, councils and committees and editorial boards of scientific publications. In the 1990s, when Russian science found itself almost adrift, A V became one of the initiators of the target program of support for the leading scientific schools in Russia aimed at retaining and strengthening the scientific schools as the most important and in many respects a unique factor in the development of science in our country. And the fact that this program, in line with the program of support of young scientists, has the high status of a program of the RF President, is in many respects a personal contribution of A V and evidence of his high scientific and moral authority.

It would not be an exaggeration to say that Academician A V Gaponov-Grekhov is a striking example of an eminent

scientist and organizer of science of whom the Russian scientific community is rightfully proud.

We heartily wish Andrey Viktorovich Gaponov-Grekhov all the best on his jubilee and wish him sound health, prosperity, and further development of the Nizhny Novgorod scientific school of radio physics whose level and scale of achievements are in many respects inseparably linked with his name.

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