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Gennadii Andreevich Mesyats (on his seventieth birthday)

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28 February 2006 marks the 70th birthday of Gennadii Andreevich Mesyats, a brilliant Russian physicist, Full Member of the Russian Academy of Sciences (RAS), Vice President of the Academy, and Director of the P N Lebedev Physics Institute, RAS. Mesyats is a recognized world scientific leader in the fields of electrophysics, the physics of electrical discharges in gases and in vacuum, and pulsed power engineering and electronics.

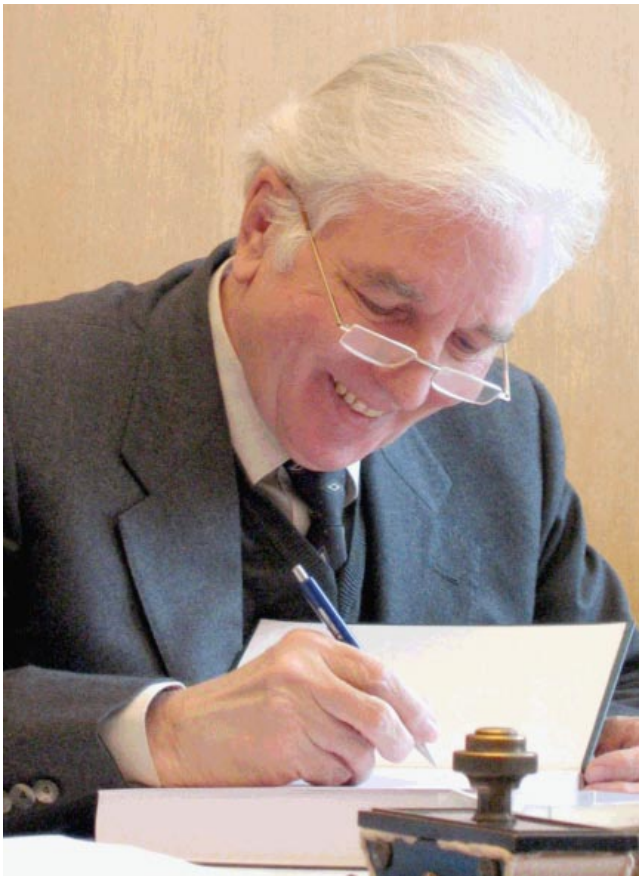
Mesyats was born in the town of Kemerovo into a working-class family and graduated with a silver medal from high school in the town of Belovo in the Kemerovo region. We can set the start of his career in science to 1957, while he was still a student at the Chair of High-Voltage Engineering at the Tomsk Polytechnic Institute (TPI). His first assignment was to build and investigate a high-voltage pulse generator with a nanosecond pulse risetime. Mesyats developed both the generator with the required parameters and a high-speed oscilloscope to record such signals. His diploma research work, done under the supervision of Professor G A Vorob'ev, was devoted to this topic and defined the course of his further career in science. The technique proved to be an excellent tool for a large number of Mesyats's physical and application-oriented research projects and was for him the focus of improvement and development for many years.

In 1961, Mesyats presented and defended his thesis "Design and investigation of high-voltage nanosecond pulsed devices with spark gaps" for Candidate of Sciences; its results greatly influenced further progress in nanosecond pulsed technology.

In 1962, he became a Senior Researcher at the Institute of Nuclear Physics of the TPI (NII YaF TPI) and actively worked there in the area of nanosecond pulsed discharges in vacuum, liquids, and gases, as well as in quantum electronics, accelerator technology, spark chambers, etc.

At this time, a number of postgraduates and engineers (graduates of various Tomsk high educational institutions) formed a group around him (B M Koval'chuk, S P Bugaev, Yu A Kotov, Yu P Usov, Yu I Bychkov, V V Kremnev, R B Baksht, D I Proskurovsky, F Ya Zagulov, and some others); with time, they grew to become leading scientists in their respective fields.

Mesyats suggested the idea of a 'peaking' capacitance in a circuit where a low-inductance capacitor or a coaxial line is charged from a Marx generator through a high-speed spark gap. An invention certificate was awarded for this type of circuit in 1962. It is now used all over the world. In 1963, Mesyats and his colleagues developed Q-switching systems for ruby lasers (the first in the USSR) in which the principal role was played by high-voltage nanosecond pulse generators designed by his group at the NII YaF TPI. This work was carried out in close cooperation with the USSR Academy of Sciences (USSR AS) Institute of Physics (FIAN: A M Prokhorov, N G Basov), Moscow State University (MGU: R V Khokhlov), the Institute of Radioengineering and Electronics (IRE: N D Devyatkov), and the Physics Institute of the Academy of Sciences of the Armenian SSR (A I Alikhanov).



Gennadii Andreevich Mesyats

In 1966, Mesyats submitted and defended his thesis "The study of the generation of high-power nanosecond pulses" for Doctorate of Sciences in which he generalized the results of the work outlined above. This thesis developed a new line of inquiry: nanosecond pulsed power engineering. Results were obtained which later reached the status of full-fledged fields of science. The first of these concerned investigations into pulsed discharges in vacuum, the second pulsed gas discharges, and the third the employment of magnetic materials for modifying the shape of high-power nanosecond pulses.

Electrooptical studies showed that the mechanism of current switching in a vacuum discharge involves the flow of plasma generated by microexplosions at the cathode, which are induced in turn by the Joule heating of microtips by the field electron emission current. It is important that the high cathode emission (a hundred times higher than field emission) be maintained in the process of plasma transfer toward the

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anode until the current closes the gap. After Mesyats this phenomenon is known as explosive electron emission (EEE) and it was recognized as a discovery with the priority data 1966. In 1967, his group developed the first high-current nanosecond electron accelerator with an EEE-based diode. This signified the birth of high-current pulsed electronics.

The second important result of Mesyats's DSc thesis was the discovery of high-pressure volumetric gas discharges (VGDs). The important property of VGDs is that at a high gas pressure (above atmospheric pressure) in air, nitrogen, hydrogen, etc., the discharge displays volumetric behavior resembling a glow discharge occurring at pressures hundreds of times lower. To achieve this effect, Mesyats suggested injecting electrons into the gas discharge gap from an external electron source. The current in an ordinary high-pressure discharge flows through a narrow plasma channel. This was also recognized as a discovery with the priority data 1966 and constituted an important event in gas discharge physics opening new possibilities for creating powerful pulsed gas lasers, plasmatrons, picosecond high-current switches, etc.

In 1968, Mesyats became head of the electronics laboratory at the NII YaF TPI. In 1970, this laboratory was transferred to the Institute of Atmospheric Optics of the Siberian Branch of the USSR Academy of Sciences where he organized the Department of High-Current Electronics and became Deputy Director of this institute.

In 1977, Mesyats initiated the foundation of the Institute of High-Current Electronics (ISE) of the USSR AS SB based on this department and became its first director. At the ISE, he pioneered — in addition to the work on EEE, VGD, gas lasers, electron accelerators, and technological electronics — investigations into relativistic microwave electronics, high-power pulsed X-ray engineering, solid-state radiation physics, electrically exploding conductors, and technological applications of electron and ion beams. The main attention in the pulse technology was focused on searching methods for fast current cutoff and on creating generators with inductive energy storage elements.

Relativistic microwave electronics is a creation of the Soviet era. It was born as a result of joint experiments conducted by FIAN and Institute of Applied Physics, AS scientists and was also an upshot of the creation of the first high-current nanosecond electron accelerators designed by Mesyats's group in Tomsk. This technology made it possible to boost the power of microwave electronic devices a thousandfold. To solve the problems of the generation of high-power pulses in the microwave range, experiments were run at the ISE on EEE in diodes with magnetic insulation and compact microwave systems for the millimeter wave band were developed, as well as repetitively pulsed microwave systems based on Sinus accelerators.

Compact pulsed electron accelerators and high-power pulsed X-ray sources with pulse lengths of $10^{-8}-10^{-9}$ s were also created and efficient opening switches based on exploding microconductors were designed. Mesyats proposed and implemented the injection thyratron. In collaboration with B M Koval'chuk, he designed plasma erosion opening switches operating on the microsecond time scale. The creation of such opening switches constituted a breakthrough in high-current electronics, as megavolt facilities for currents up to 10^7 A became considerably more compact and less expensive.

In 1979, Mesyats was elected a Corresponding Member and in 1984 became a Full Member of the USSR Academy of Sciences.

Beginning in 1986, Mesyats headed the Ural Scientific Center of the USSR AS. He invited 25 scientists from Tomsk, Novosibirsk, and Moscow to Sverdlovsk to establish a new institute. Many of them later headed laboratories at the Institute of Electrophysics (IEF UrB RAS) that Mesyats set up in 1986. He was confirmed as IEF Director.

Sverdlovsk is a town with famous science traditions; nevertheless, electrophysics, laser physics, and radiophysics never before flourished in Ural academic institutes. The new institute had to survive during the unenviable 1990s; however, the young team not only withstood the storms but quickly earned a high international reputation and a proud place at the side of its elder sibling — the institute in Tomsk.

The Ural institute has a clearly recognizable signature. Its work in the fields of high-current pulse technology, charged particle accelerators, electromagnetic oscillators, and technological electron and ion sources is widely known. Various devices created at the Institute of Electrophysics are used successfully in Russia and abroad (USA, Great Britain, P.R. China, France, etc.).

The following achievements by the IEF UrB RAS deserve to be singled out as brilliant. The discovery of ectons — electron and plasma packets that are generated in the course of explosive electron emission. It was proved that ectons play a fundamental role in the cathode spots of vacuum arcs, in some types of gas discharge, in unipolar arcs, etc. The discovery of the SOS effect in silicon semiconductors, which made it possible to develop a whole new class of high-power semiconductor opening switches and pulse generators. The creation of picosecond pulse power systems and picosecond electronic devices. The discovery of the superemission by picosecond electron beams that resulted in achieving a power of microwave radiation several times higher than that of the electron beam. The development of techniques for manufacturing materials from nanopowders by magnetic compression, identification of materials by nanosecond electron beams, etc.

Mesyats has published more than 500 scientific papers and 20 monographs. These are such widely known volumes as *Methods of Formation of High-Voltage Nanosecond Pulses* (1963), *Generation of High-Power Nanosecond Pulses* (1974), *High-Power Nanosecond X-Ray Pulses* (1983), *Pulsed Electrical Discharge in Vacuum* (1984), *Pulsed Gas Lasers* (1991), *Physics of the Pulsed Breakdown in Gases* (1991), *Ectons* (in three volumes, 1993 – 1994), *Ectons in a Vacuum Discharge*: *the Breakdown, the Spark, and the Arc* (2000), *Pulsed Power* (2004) and others. Most of his publications have been translated into English, Chinese, and Japanese. He has received 42 patents and invention certificates.

Mesyats has actively trained new generations of scientists. He founded the Chair of Plasma Physics at Tomsk State University and the Chairs of Electrophysics at Ural Technical University and the Moscow Institute of Physics and Technology. Among his former students we find more than 40 Doctors of Sciences and more than 100 Candidates of Sciences. Six among them are members of the Russian Academy of Sciences.

Mesyats is also an important science manager. In 1986, he was elected a member of the Presidium of the USSR Academy of Sciences, and in 1987 Vice President of the USSR AS. In 1987, he initiated the foundation of the Ural Branch of the USSR AS (UrB AS USSR) which incorporated the Ural Scientific Center plus the Bashkiria and Komi affiliates of the AS USSR (transformed later into scientific centers of the UrB

AS USSR. Scientific centers were also created in Izhevsk, Chelyabinsk, Orenburg, and Arkhangel'sk. That same year he was elected chairman of the UrB AS USSR. At the same time he headed the USSR AS Commission on Coordination of Science in the Russian Federation (RSFSR). Mesyats was a member of the Organizing Committee on establishing the Russian Academy of Sciences (RAS), in which he headed the section of physics, nuclear physics, and power engineering. After the USSR AS was transformed into the RAS, he was elected in 1991 Vice President of the RAS, and Chairman of the UrB RAS. In 1998, he left the post of UrB RAS chairman owing to his transfer to Moscow but remained Director of the Institute of Electrophysics until 2004. In 2004, Mesyats was elected Director of the P N Lebedev Institute of Physics of the RAS, continuing with scientific supervision of the institutes of his creation — ISE SB RAS and IEF UrB RAS.

Mesyats holds the Lenin Komsomol Award (1968), the USSR (1978) and Russian Federation (1998) State Prizes, the USSR Government Prize (1990) and the Russian Federation Government Prize (2003), the Demidov Award (2002), the Global Energy Award (2003), and the International W Dyke (1990) and Erwin Marx Awards (1991). He also received such academic distinctions as the A G Stoletov Award (1995), S V Vonsovsky Gold Medal (2004), and M A Lavrent'ev Gold Medal (2005). Mesyats was awarded The Order of Lenin (1986), The Order of a Red Banner of Labor (1971), The Order of Honor (1976), and Orders of Service to the Motherland of Fourth Class (1996) and Third Class (1999).

We wish Gennadii Andreevich Mesyats good health, many years of creative work and inexhaustible energy (his trademark!) for bringing to fruition numerous grandiose and illustrious undertakings.

Zh I Alferov, A F Andreev, V L Ginzburg,
N S Kardashev, L V Keldysh, B M Koval'chuk,
S D Korovin, O N Krokhin, M V Sadovsky,
E L Feinberg, V E Fortov, V G Shpak