Physics – Uspekhi **48** (10) 1085 – 1086 (2005)

PERSONALIA

PACS number: **01.60.+q**

Yurii Vasil'evich Gulyaev (on his seventieth birthday)

DOI: 10.1070/PU2005v048n10ABEH005894

Yurii Vasil'evich Gulyaev, Full Member of the Russian Academy of Sciences, a well-known figure in radiophysics, electronics and informatics, celebrated his seventieth birthday on September 18, 2005.

Gulyaev was born in 1935 in the settlement of Tomilino of the Lyuberetsky district in the Moscow region. He graduated from the Radiophysics Department of the Moscow Institute of Physics and Technology (MFTI) in 1958, presented and defended his CSc thesis in 1962, and his DSc thesis in 1970. Since 1960, Gulyaev worked at the Institute of Radio-engineering Electronics of the Russian Academy of Sciences (IRE RAS, or IRE USSR AS before 1991) as a Junior Researcher, then Senior Researcher, Head of laboratory, Deputy Director (1972 – 1988) and IRE Director (1988 onwards). After 1964, he also started to teach at the MFTI, rising in 1971 to full professorship and to Head of a chair. He was elected a Corresponding Member of the USSR Academy of Sciences in 1979 to the General Physics and Astronomy Division, and in 1984 became a Full Member of the Informatics, Computation Engineering and Automation Division of the USSR AS. Since 1980, Gulyaev chairs the Presidium of the RAS Saratov Research Center; from 1992 up to the present day he has joined the RAS Presidium and become Vice-Academician-Secretary of the RAS Division of Information Technologies and Computation Systems, Chair of the Section of Computation, Radar and Telecommunication Systems and Electronics Components.

Having started his life in science in 1958 under the supervision of outstanding physicists V L Bonch-Bruevich and S G Kalashnikov, Gulyaev made an important contribution to the investigation of nonequilibrium electron processes in semiconductors. He analyzed in detail the so-called impact mechanism of charge carrier recombination in semiconductors, which plays an important role in heavily doped and narrow-band-gap semiconductors. He was able to construct, for the first time, a statistical theory of recombination of charge carriers on dislocations in semiconductors, considered the statistics of dislocation occupancy in equilibrium conditions, found formulas for charge carrier lifetimes, and studied the effect of electric fields around dislocations upon recombination. This and other results obtained by Gulyaev in the theory of recombination of charge carriers in semiconductors gained wide recognition both in this country and abroad and are widely used in calculating the speed of response in semiconductor devices.

In 1962 – 1963, Gulyaev worked in England at Manchester University, where he concentrated on the problems of electrical conduction in heavily doped semiconductors. Gulyaev and S F Edwards were the first to apply the techniques of continual (Feynman) integrals to derive the general formula for the density of states in heavily doped semiconductors that covered all known particular cases.

Uspekhi Fizicheskikh Nauk **175** (10) 1141 – 1142 (2005)
Translated by V I Kisin

Yurii Vasil'evich Gulyaev

A series of papers written by Gulyaev in the mid-1960s treated propagation of electromagnetic waves in semiconductors and predicted a number of novel effects. Among these were the 'radioelectric effect' — that is, generation of dc emf in a semiconductor in response to transmission of electromagnetic waves, the dependence of photoconductivity on the polarization of the incident radiation, negative photoconductivity of semiconductors in a quantized magnetic field, and the Faraday effect on hot electrons in semiconductors. This last effect makes it possible to develop ultrasensitive infrared and millimeter wave detectors with sensitivity on the order of 10^{-13} W $Hz^{-1/2}$.

Gulyaev was one of the creators of a new branch of solid state physics and technology — acoustoelectronics — that studies effects and phenomena connected with propagation of high-frequency (above 1 MHz) ultrasound waves in solids and their interaction with electromagnetic fields and charge carriers.

In 1964, Gulyaev together with V I Pustovoit suggested the idea of using surface acoustic waves (SAWs) in electronics and proposed a layered piezoelectric – semiconductor structure as a base design of acoustoelectronic devices.

This idea was further advanced in a paper of R White and F Voltmer (USA, 1965), where they suggested an electric-field excitation of SAWs using a periodic structure of interdigital metallic combs of electrodes on the piezoelectric surface. These two papers were the first publications that proposed using SAWs for processing information-carrying signals. In 1977, Gulyaev together with A M Kmita and A S Bagdasaryan proposed a novel type of transducer for the excitation and reception of surface acoustic waves, based on capacitive weighing of electrodes and leading to SAW-based devices with the best characteristics of filters, delay lines, etc.

In 1968, Gulyaev, and at the same time and independently the American physicist J L Bleustein, predicted and investigated a novel fundamental type of SAWs, known in world literature as Bleustein – Gulyaev waves.

Gulyaev theoretically predicted and analyzed a new class of kinetic phenomena in semiconductors that involves entrainment of electrons by acoustic waves: the acoustomagnetoelectric effect (1966, Discovery Certificate No. 133), acoustothermal and acoustomagnetothermal effects, acoustoconcentration effect causing acoustoluminescence, and acoustomagnetic effects.

In 1971, Gulyaev suggested the so-called 'acoustic-injection transistor', the first device in a range of semiconductor devices with acoustic charge transfer. Nowadays, this branch of semiconductor electronics is expanding vigorously.

Gulyaev and his co-workers predicted and studied the transverse acoustoelectric effect on SAWs; the underlying processes form the basis of devices for rapid Fourier transform, convolution, correlation, and other types of radio signal processing.

This and other work by Gulyaev and his co-workers, as well as the acoustoelectronics research of other Russian and foreign colleagues, created a new line of inquiry in the technology of data processing, communications, and radar systems, which continues to greatly expand. On the world scale, the annual production of acoustoelectronic devices that constitute important components of TV and radio sets, radar facilities, as well as navigation and telecommunications systems, and more recently of cell phones, reached billions of units.

Gulyaev made important contributions to the progress in acousto-optics and its practical applications. Together with his colleagues, he predicted and discovered a number of novel acousto-optical effects, among them light diffraction by electron waves that accompany the propagation of sound in semiconductors, and light diffraction by sound waves in lasing media (including the distributed acoustic feedback effect in lasers), and also studied resonant and nonlinear acousto-optical phenomena in solids. Gulyaev together with fellow-Academicians V A Kotel'nikov, A M Prokhorov, Zh I Alferov, G G Devyatykh, and a number of other scientists and engineers took part in organizing the work of researching and practical implementation of fiber optics in this country.

In 1965, Gulyaev predicted the existence of the so-called 'second spin waves' in ferromagnets (an analog of the second sound in liquid helium that was predicted by L D Landau) and constructed their hydrodynamical theory. Together with P E Zil'berman and their teams, Gulyaev developed a kinetic theory of interaction between spin waves and electrons in ferrite – semiconductor and ferrite – superconductor layered structures and studied resonance phenomena in thin ferromagnetic films and in periodic structures on the surface of ferromagnets. This work formed the basis for manufacturing unique high-frequency high-Q filters and delay lines for the microwave range.

Gulyaev and S A Nikitov investigated certain nonlinear phenomena accompanying the interaction of spin waves with electrons in magnets and suggested the creation of a new class of magnetic materials, the so-called 'magnon' crystals.

From 1980 on, Gulyaev and N I Sinitsyn and their colleagues studied the functional possibilities of vacuum integrated circuits based on the distributed interaction of microwave fields and electron fluxes, and proposed a number of microelectronic vacuum microwave devices with distributed interaction, based on field emitter matrices. In 1993, Gulyaev and Sinitsyn advanced the idea of utilizing carbon fullerene nanotubes as field emitters in vacuum microelectronic devices. Research based on this idea is being carried out intensely in many laboratories the world over; the first display devices with brightness exceeding that of liquid-crystal displays have already been created.

In 1978, Gulyaev suggested and later successfully implemented a new, 'radiophysical' approach to studying the functioning of the human organism, based on integrated measurements of physical fields and emissions of the living body. A number of working groups in the leading medical organizations, using these measurements as a starting platform, continue to develop new techniques of early noninvasive medical diagnostics, which builds a foundation for the preventive medical science of the future.

Having been elected in 1989 as the USSR People's deputy and held the post of Chairman of the Subcommittee of the Supreme Soviet of the USSR on Informatics and Communications, Yu V Gulyaev devoted a great deal of time and effort to working out an integrated program of development of telecommunication systems in the USSR. This program is in fact being implemented in Russia at the present time.

The contributions of Academician Gulyaev to progress in science and technologies were rewarded with prestigious prizes and distinctions: The European Physical Society Prize (1979), two State Prizes of the USSR (1974, 1984), the USSR Council of Ministers Prize (1989), the Russian Federation State Prize (1993), the B P Konstantinov Prize of the RAS (1991), and the A S Popov Gold Medal (1995), as well as a number of orders and medals, including For Public Service to the Fatherland orders of Third and Fourth Classes.

Gulyaev carries a considerable load of social duties. He is President of the International and Russian Scientific and Engineering Unions, President of the A S Popov Russian Scientific and Technological Society of Radioengineering, Electronics and Telecommunications, Vice-President of the World Federation of Engineering Organizations, and Chairman of the Russian section of the Institute of Electrical and Electronics Engineers.

In his unofficial capacities, we know Gulyaev as a sweet and charming man who is always ready to help his friends, colleagues, and students and is fully capable of playing a major role in a lively get-together.

Friends, colleagues, and disciples send Yuri Vasil'evich Gulyaev their best wishes on this wonderful jubilee and wish him good health, happiness and new successes in his creative career.

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A A Boyarchuk, A S Bugaev, E P Velikhov,
V L Ginzburg, A L Mikaelyan, S A Nikitov,
V I Pustovoit, V A Sadovnichii, V E Fortov