

Andrei Georgievich Zabrodsii (on his 80th birthday)

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June 26, 2026 marked the 80th birthday of Andrei Georgievich Zabrodsii, academician of the Russian Academy of Sciences (RAS), professor and chief researcher at the A.F. Ioffe Physical-Technical Institute (PTI) working in the fields of condensed matter physics, physical materials science, and applied physics.

Zabrodsii's involvement in research began during his years at the Leningrad Polytechnic Institute (LPI), when a student, working on his thesis in the Zh.I. Alferov Department of the A.F. Ioffe Physical-Technical Institute (Phystech) registered multibeam heterolaser radiation patterns and understood their nature, reducing the issue to an electrodynamic problem of exciting higher-order transverse modes in a dielectric waveguide. Then it was a red diploma, a military ID, lieutenant service, and the PTI graduate school since 1972.

A.G. Zabrodsii's graduate student supervisor professor S.M. Ryvkin suggested pursuing the rapidly developing field of disordered system physics, specifically the nature of electrical bistability effect in heavily doped compensated semiconductors. It was found that this effect was based on the impact ionization of the main impurities, complicated by various manifestations of disorder. However, in the simpler ohmic regime, experiments stubbornly failed to confirm Mott's law for variable-range hopping (VRH),¹ popular at that time, which made A.G. Zabrodsii tackle this problem, starting with the material.

At the intersection of semiconductor and nuclear physics, Andrei Georgievich conducted a series of original experiments based on unique properties of neutron transmutation of Ge, which is a natural mixture of five isotopes. As a result of radiative capture of neutrons by them and a subsequent radioactive decay, a hydrogen-like donor As, a deep doubly charged donor Se, and a basic transmutation impurity, a shallow acceptor Ga, with half-lives of about an hour, a day, and ten days, respectively are formed. Therefore, if accompanying radiation defects are annealed immediately after irradiation in a nuclear reactor, a stepwise movement of the Fermi level through the forbidden band can be observed as a result of capture of electrons from the already formed donors by the forming acceptors. By recording these steps, A.G. Zabrodsii was able to significantly refine the then poorly known nuclear-physical constants of the doping Ge isotopes and create a method for varying the yield of transmutation impurities by changing the neutron spectrum hardness using filters. The applied output consisted in solving



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the problems of manufacturing uniformly doped Ge:Ga with fixed compensation for the first domestic deep-cooled high-sensitivity bolometers and cryothermistors, as well as a series of Ge:As and Ge:Ga samples with controlled doping levels and compensation for studying hopping transport problems.

To investigate the VRH regime sensitive to the behavior of the density of states in the vicinity of the Fermi level, but lacking a constant activation energy and therefore difficult for examination, A.G. Zabrodsii developed a high-precision methods of the VRH analysis and proved the existence of a narrow quasi-gap in the density of localized states at the Fermi level used the obtained series samples and then other disordered systems. For the case of high compensations (far from the insulator–metal transition), he could identify such a quasi-gap with a one-electron model of the Efros–Shklovskii Coulomb gap, a kind of ‘exciton’ effect of hopping electron attraction to a hole occurring in its place. With his student A.G. Andreev, he discovered the existence of anomalously narrow multielectron-nature Coulomb gaps.

¹ N.F. Mott was a 1977 Nobel Prize winner “for fundamental theoretical studies of the electron structure of magnetic and disorder systems.”

The experience in studying Coulomb gaps was used by A.G. Zabrodskii, together with K.N. Zinov'eva, in their experiments on one of the central problems in disordered system physics, namely, insulator–metal (IM) phase transition. The transition turned out to be a Coulomb gap collapse at a critical point because of divergence of static permittivity. Advancement in these experiments to ultralow temperatures (tens of mK) allowed tracing the collapse down to small neighborhoods of the Fermi level. Critical parameters of IM transition appeared to depend on the occupation density of states of the impurity band of the semiconductor (degree of compensation).

Using electron paramagnetic resonance (EPR) techniques, A.G. Zabrodskii, in collaboration with A.I. Veinger, developed and widely used highly sensitive, non-contact methods for studying ‘dirty’ metals, superconducting, insulating, and metallic clusters, as well as weak magnetoresistive effects. These methods were used to study nanoscale clusters in Si–Ge solid solutions that limit the capabilities of the materials of instrument structures created on their basis. Long before the discovery of iron-based superconductors, superconductivity was revealed in iron-containing clusters in glasses. Also registered was the effect of pulling the manifestation of the Pauli paramagnetism towards the insulator in the IM transition at temperatures sufficient for Coulomb gap thermal closure.

But these methods were mainly used in investigation of low-temperature effects of interaction of spins localized on donors in the region of IM transition. It turned out that such effects can result in the formation of a singlet (antiferromagnetic) or a triplet (ferromagnetic) state, the manifestation of the latter being promoted by a moderate occupation of impurity band states and low temperatures. The ability of a nonmagnetic semiconductor with hydrogen-like impurities to get magnetized near an IM transition was directly proved in experiments of A.G. Zabrodskii, A.G. Andreev, and R.V. Parfen'yev on observation of magnetoresistance hysteresis in the VRH regime in a neutron-doped Ge:Ga, and then by the measurements of Si:P magnetization curves using SKVID magnetometer, performed by A.G. Zabrodskii, A.I. Veinger, and P.V. Semikhin.

In collaboration with N.A. Poklonsky (Belarus), A.G. Zabrodskii carried out dozens of works on advancing the theoretical description of screening effects, various charge correlations, polaron formation, hopping transport in crystalline semiconductors (including multilevel ones) far beyond the previously studied weak doping limit (up to IM phase transition), as well as on studying the magnetic ordering effects near a transition. Among the latter are the construction of a model of the so-called ε_2 -conductivity (in which, in contrast to the well-known Hubbard model, tunnel electron transitions between the main impurities are considered), which for the first time described its observed behavior in the insulator side of IM transition in Ge and Si; explanation of the antiferromagnet–ferromagnet–paramagnet transformation with increasing compensation near the IM transition; investigation of the influence of clustering of spin radicals formed by radiation defects on superparamagnetism of polycrystalline diamond.

The work of A.G. Zabrodskii's as head of the laboratory (1989–2017), deputy director (1998–2003), and director (2003–2018) of the Physical-Technical Institute stimulated the expansion of his research topics towards large applied and infrastructure projects.



With his wife Valentina. Andorra, 2002.

In collaboration with V.K. Eremin, a number of problems in the physics of radiation-tolerant detectors and the creation of their fundamentally new designs for high-energy physics were solved. Thus, within the framework of the international CERN collaborations, RD-39 (cryogenic detectors), RD-42 (diamond detectors), and RD-50 (silicon detectors), a new type of detectors—‘detectors with edge sensitivity’ was created for the study of small-angle scattering of direct beam ions from the Large Hadron Collider (LHC) in TOTEM experiments.

Under the leadership of A.G. Zabrodskii, a series of research and development projects was conducted within the framework of the RAS–Norilsk Nickel hydrogen energy program, leading to the creation of efficient compact power sources based on technologies of air-hydrogen fuel elements, worked out in several PTI laboratories, whose active catalytic layer was formed of carbon nanotubes, soot microparticles, and ionomers. Possessing a specific energy capacity comparable with world-class analogs, the experimental samples surpassed them in stability of operating characteristics under varying temperature, humidity, and air convection.

Under the leadership of A.G. Zabrodskii, Phystech became a participant in a large-scale project to develop and modernize industrial solar module manufacturing technologies as part of a research and production consortium, together with the Center for Thin Film Technologies in Energetics (CTTE LLC ‘Hevel’ supervised by E.I. Terukov) founded on its premises in 2012 and staffed by highly qualified PTI researchers, as well as the Hevel plant in Novocheboksarsk. The project culminated in the plant's reconstruction and transition to the production of two times more effective modules based on silicon a-Si:H/c-Si heterostructures elaborated at CTTE, making it the leading manufacturer of these modules in the Russian Federation.

A.G. Zabrodskii and V.V. Zhdanov implemented an infrastructure project of creation of a scientific and technological complex ‘Lithium-ion technologies,’ which ensured the implementation of research and development works (R&D) on industrial orders in the field of developing lithium-ion batteries and high-power-density batteries.

A.G. Zabrodskii initiated and headed up to 2018 a large-scale and elaborately implemented investment project for creation an R&D center at PTI, aimed at modernizing and developing the infrastructure of the heterostructure technologies complex, founded by academician Zh.I. Alferov, to fulfill orders from enterprises in the country's high-tech complex.

The Phystech project to modernize its spherical tokamak, ‘Globus M2’ (headed by V.K. Gusev), also became stressful for A.G. Zabrodskii, especially after it faced the threat of failure caused by a serious accident during the pre-launch period.

In 2015, with the support of the research supervisor of the Institute of Cytology RAS, academician N.N. Nikol'sky, A.G. Zabrodskii organized the scientific community 'Physics to life sciences,' which involves scientists from research centers and universities of St. Petersburg and other cities of the country, who are carrying out research and development of approaches, methods, materials, technologies, and devices at the intersection of physics, medicine, biology, and agrotechnology with holding regular conferences of the same name.

Under the leadership of A.G. Zabrodskii, Phystech diversified its budget sources through funds, business contracts, and investments; it established itself as Russia's leading scientific centers in the fields of 'generation of knowledge' and 'technology,' despite the crises of 2008 and 2014–2015, it avoided mass layoffs in the number of research staff, whose salaries significantly outpaced inflation; and at the suggestion of RAS it started independent publications of five scientific journals established jointly with RAS.

In 1993–2003, A.G. Zabrodskii taught the General Physics Course at St. Petersburg State Polytechnical University (SPbSPU) and organized an optional seminar on extracurricular sections to attract students interested in physics, many of whom later connected their lives with Phystech. In 2006–2021, he headed the basic Department of Physics and Technology of Solid-State Electronics, founded by him at St. Petersburg State Electrotechnical University (SPbSETU — LETI), where, in particular, specialists were trained for the 'Hevel' plant in Novocheboksarsk. For 30 years already, he has been organizing the annual PTI International Winter School on Semiconductor Physics, whose students have become doctors of sciences, professors and members of RAS. On the initiative of A.G. Zabrodskii, IPT became a participant in the program for independently awarding academic degrees and increased the size of its graduate school by more than 50%.

In 2008, A.G. Zabrodskii was elected a corresponding member, and in 2016 a full member of RAS. As a member of the RAS Presidium from 2017 to 2022 and the Bureau of the Physical Sciences Division from 2008 to 2022, he participated in the creation of the RAS branch in St. Petersburg and in organizing the expert activities of RAS. He is the editor-in-chief of the journal *Zhurnal Tekhnicheskoi Fiziki* (*Journal of Technical Physics*), founded by academician A.F. Ioffe in 1931, a member of the Scientific-Publishing Council of RAS and its Bureau, a participant in the nationally oriented reform of the scientific publishing activities of RAS.

He is a laureate of the prizes of the USSR Council of Ministers (1983) and the RF Government (2018) in science and technology. He was awarded the Orders of Friendship and Honor.

His extreme sports hobbies (canoe tourism and Alpine skiing) gradually gave way to forest walks and handicraft activities to maintain a peasant house in the Pskov region (in the 1990s) and, since the 2000s, the dacha built near St. Petersburg.

We heartily wish Andrey Georgievich good health and new achievements in science, as well as the development of Phystech and the Academy!

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