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Aleksandr Sergeevich Sigov (on his 80th birthday)

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On May 31, 2025, doctor of physical and mathematical sciences, Professor Aleksandr Sergeevich Sigov, academician of the Russian Academy of Sciences (RAS), an outstanding scientist and organizer of science, president of MIREA — the Russian Technological University (RTU MIREA) — turned 80.

A.S. Sigov was born in the city of Stalino (Donetsk) in 1945. In 1962, he finished secondary school No. 78 in Kiev with a gold medal and in 1969 graduated with honors from the Physics Department of M.V. Lomonosov Moscow State University (MSU). During his student years, he began to study electrodynamic instabilities in deep-level semiconductors under the scientific supervision of an outstanding scientist, future academician Leonid Veniaminovich Keldysh, and regularly attended on Wednesdays the famous seminars of academician V.L. Ginzburg (a 2003 Nobel Prize winner in physics) at the P.N. Lebedev Physical Institute of the USSR Academy of Sciences (FIAN).

In 1972, after completing his postgraduate studies and defending his candidate thesis, he was sent to work at the Moscow Institute of Radio Engineering, Electronics, and Automation (MIREA, now RTU MIREA), where he is still working today.

Since 1974, on the initiative of doctors of physical and mathematical sciences A.P. Levalyuk and V.V. Osipov, he began to study the influence of defects on the anomalies of the physical properties of crystals near the points of structural and magnetic phase transitions. As a result, in 1985, he defended his doctoral thesis, "The influence of defects on the physical properties of crystals near structural and magnetic phase transitions" at the Physics Department of MSU.

A.S. Sigov is a leading specialist in the field of condensed matter physics, statistical physics, phase transition physics, ferroelectricity, magnetism, and micro- and nanoelectronics. He is characterized by an unusually high performance and broad erudition, allowing him to effectively work simultaneously in a number of scientific fields. At present, the scope of his scientific activity is the study of the physical properties of systems with lowered dimensionality and/or structural disorder and the creation of functional devices of nano- and microelectronics based on them.

A.P. Levanyuk and A.S. Sigov formulated a consistent phenomenological theory of the influence of defects on the anomalies of the physical properties of crystals near structural and magnetic second-order phase transitions, established the conditions of its applicability, and found the contributions of different types of defects to anomalies of a wide range of physical characteristics. For defects of the 'local phase transition temperature' type, the scaling theory for an inhomogeneous system was shown to be inapplicable. For extremely low defect concentrations, the scaling regime, which is inherent in the system in the absence of defects, can take place, and when approaching the transition point, the system switches over to the strong coupling regime. For considerable defect concentrations, the system switches over to the strong coupling regime already in the applicability region of the mean field approximation.

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Then, A.S. Sigov, together with V.R. Chechetkin, was carried away by the solution to the topical problem of superconducting magnetic system stability under the influence of weak random thermal disturbances. Within the framework of the Lyapunov functional theory, they obtained general criteria of stability with respect to final thermal perturbations, formulated the corresponding variational principle, and determined an admissible level of temperature fluctuations for a given current.

A.S. Sigov and his brilliant younger colleague A.I. Morozov investigated a number of problems, including the muon

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spin relaxation in metals with defects. The authors showed that the experimentally observed relaxation is due to muon capture by a trap, the role of which can be played by any point or extended defect of the crystal lattice. A detailed plan of experiments was formulated to obtain quantitative information on local magnetic fields and on quantum muon diffusion in metal. In the study of the interaction of deffectons with conduction electrons, consistent account was taken of infrared renormalizations that significantly affect the deffecton zone width and their contribution to the physical properties. Clustering of deffectons due to their interaction with each other and with defects of other types was considered. Temperature dependences of the kinetic coefficients of a metal containing free deffectons and two-level systems occurring in some cases when a deffecton is trapped by a heavy immobile impurity were found.

For multilayer magnetic nanostructures, which are the basis of promising magnetoresistive memory devices, it was shown that, in a multilayer ferromagnet-antiferromagnet (FM–AFM) system, the behavior of the order parameters in nanometer-thick layers is largely determined by frustrations arising at the interfaces between the layers. New types of domain walls generated by frustrations of exchange interaction were predicted and then observed experimentally. Their width is determined by the competition of exchange interactions within and between the layers and turns out to be much smaller than the width of traditional domain walls. 'Layer thickness–roughness' phase diagrams of the FM film on the AFM substrate and the spin-valve FM–AFM–FM system were plotted. The presence of mutually perpendicular easy axes lying in the plane of the layers was found to be favorable for the occurrence of exchange shift in the FM–AFM system. Moreover, a bound state of the boundary at the interface or wall pinning by AFM lattice defects near the boundary with the FM must exist.

The causes of and conditions for the occurrence of Imry-Ma phases, in which the direction of the order parameter follows large-scale fluctuations of anisotropy, were investigated in detail in systems with 'random local field' and 'random local anisotropy' type defects. In particular, the possibility of the occurrence of the Imry-Ma phase in a space of dimension exceeding the lower critical value was shown. The anisotropy of random field distribution in the order parameter space induces a global anisotropy, which can lead to a suppression of the disordered state and the appearance of long-range order. Phase diagrams conditioned by a competition between random fields and induced anisotropy were plotted. Studied for nanocrystalline FM were the dependences of a coercive field on the crystal size in systems of different dimensions.

The main thrust of A.S. Sigov's activity as president of RTU MIREA is organizing research work and developing scientific infrastructure. In the last five years, he has organized four international scientific and technical conferences "Fundamental Problems of Radio-Electronic Instrument Engineering," as well as the European Conference "Applications of Polar Dielectrics."

Dozens of scientific projects within state programs and grants from the Russian Foundation for Basic Research (RFBR) and the Russian Scientific Foundation (RSF) have been implemented under the leadership and with participation of A.S. Sigov. From 2013 to 2024, A.S. Sigov was the head of the RFBR Expert Council for Physics and Astronomy. He is now head of the Center of Integral Microwave Photonics and actively develops relations with leading higher educational institutions and research centers in China, Taiwan, Holland, Japan, France, Portugal, the USA, Great Britain, and Uzbekistan.

In recent years, A.S. Sigov has organized several research and technological projects aimed at solving import substitution problems and created an original lecture course, "Physics of active dielectrics." A forty-year old scientific school Functional dielectric and magnetic structures, founded by A.S. Sigov, is being successfully developed. In the last five years, those involved in the school's activities have successfully conducted work on two RSF megagrants ("Photo-induced spin dynamics in magnetoelastic and straintronic multiferroic nanostructures" and "Research and development of new types of mesoporous organosilicates with improved mechanical properties for subtractive metallization of integrated microcircuits"). Three doctoral and seven candidate theses, as well as defended three doctoral and seven candidate theses under the guidance of A.S. Sigov. The scientific achievements lie in the field of searching for and characterizing functional materials for terahertz and neuromorphic applications.

Members of one scientific group of the school have designed and created a prototype of a polarization-sensitive phototransistor based on two-dimensional graphene-like semiconductors and constructed complex computer models that allow predicting the parameters of such devices. An experimental sample of a spintronic emitter with polarization control by an external magnetic field has been created, surpassing all known counterparts in efficiency of optical-to-terahertz conversion. In the field of nondestructive methods for studying nanomaterials, the method of polarimetry of the second optical harmonic signal for magnetic media was successfully applied for the first time, allowing visualization of magnetization components, including in the domain boundary region.

Another scientific group has theoretically and experimentally substantiated and practically implemented a new area of microelectronics, namely, integrated ferroelectric devices for the element base of information systems. Physical and chemical bases for the formation of thin films and nanostructures of active dielectrics, organic-inorganic hybrids, and low-permittivity dielectrics for the element base of electronics based on new physical principles were created.

A.S. Sigov has published over 500 scientific papers, 16 textbooks and teaching aids, and 9 monographs and also received 40 patents.

Appointed by a decree of the president of the Russian Federation in 2024, A.S. Sigov serves as the head of the Committee on Defense-Industrial Security and a member of the Bureau of the Scientific Expert Council of the RF Security Council. He was elected deputy academician-secretary of the Department of Nanotechnology and Information Technology of RAS, is head of the section of the physics of ferroelectrics and dielectrics, and is a member of the Bureau of RAS Council for Physics of Condensed Media.

A.S. Sigov is a deputy editor-in-chief of the international journals *Ferroelectrics and Integrated Ferroelectrics* (USA), editor-in-chief of the journals *Elektronika. Nauka, Tekhnologiya, Biznes* (*Electronics: Science, Technology, Business*) and *Russian technological journal* (*Rossiiskii tekhnologicheskii zhurnal*, published in English and in Russian), and a member

of the editorial boards of the journals *Izvestiya RAN. Seriya Fizicheskaya* (*Bulletin of the Russian Academy of Science: Physics*); *Intellektual'nye sistemy. Teoriya i Prilozhniya* (*Intelligent Systems. Theory and Applications*); *Nano- i Mikrosistemnaya tekhnika* (*Nano- and Microsystems Tekhnology*); *Fotonika* (*Photonics Russia*); *Inzhenernoe obrazovanie* (*Engineering Education of Russia*) and *Izvestiya Vysshikh Uchebnykh Zavedenii. Elektronika* (*Russian Microelectronics*). He represents Russia in organizing and program committees of international conferences. He is a member of the European Physical Society, Institute of Physics, Institute of Electrical and Electronics Engineers, Institution of Engineering and Technology, and Materials Research Society, and is chair of the board of the Association for Engineering Education of Russia.

A.S. Sigov has the honorary title of Honored Scientist of the Russian Federation, and he is a laureate of three Government Prizes and the State Prize of the Russian Federation in the field of science and technology. He was awarded the Order of Merits for the Fatherland of the IV and III degrees, the Order of Honor, and a medal and diploma from UNESCO "For contribution to the development of nanoscience and nanotechnology."

Friends and colleagues wish Aleksandr Sergeevich Sigov sound health and further success on his remarkable birthday!

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