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In memory of Boris Petrovich Zakharchenya

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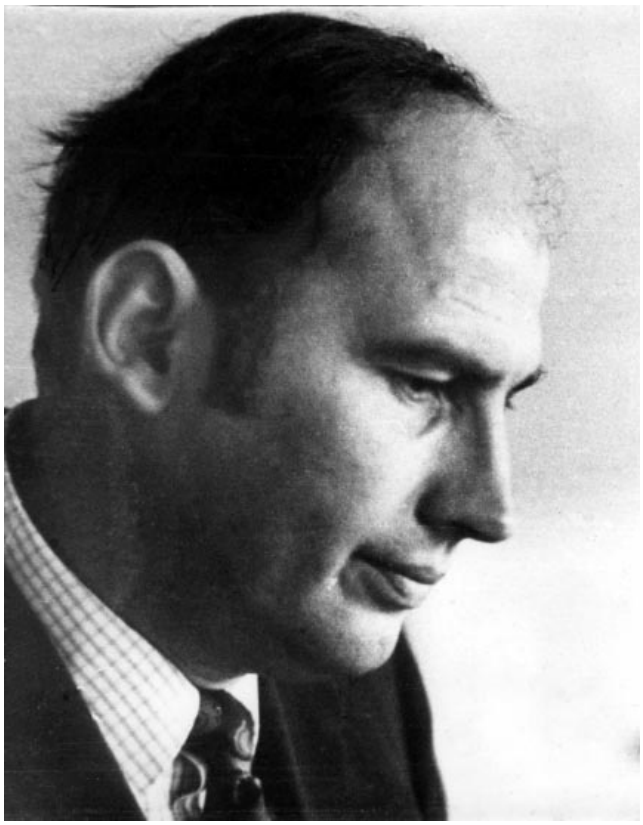
Boris Petrovich Zakharchenya, an outstanding Russian scientist whose work contributed importantly to modern solid-state physics, passed away on 10 April 2005.

Zakharchenya was born on May 1, 1928 in the small Belarussian town of Orsha into the family of a military engineer. He graduated from secondary school in Leningrad where the family had lived since the first half of the 1930s, and in 1947 he enrolled in the Physics Department of Leningrad State University from which he graduated cum laude in 1952. The same year Zakharchenya found a position at the A F Ioffe Physical-Technical Institute (FTI in Russ. abbr., known as FizTekh) where he worked all his life and rose from senior technician to Director of the FTI Solid State Physics Division. Zakharchenya defended his thesis for Candidate of Physicomathematical Sciences in 1955, and his doctoral thesis in 1966. In 1976, he was elected Corresponding Member of the USSR Academy of Sciences, and in 1992 became Full Member (Academician) of the Russian Academy of Sciences (RAS).

Zakharchenya started his long life in physics at the FTI Optics Laboratory under the guidance of Evgenii Fedorovich Gross — a brilliant world-famous spectroscopist who in 1930 made an experimental discovery of Brillouin light scattering in condensed media. Not long before Zakharchenya joined the laboratory, Gross and Karryev discovered there in 1951 a hydrogen-like series of lines in the absorption spectrum of cuprous oxide (Cu_2O) crystals, caused by the excitation of excitons. Zakharchenya was immediately immersed in the atmosphere of active scientific quest that reigned in the laboratory and aimed at the experimental investigation of the properties of these new quasiparticles whose existence in crystals was predicted earlier by theorists (Frenkel', Wannier, Mott). The young Boris Zakharchenya, Gross's favorite pupil, observed for the first time in Cu_2O crystals, which had become the favorite model crystals for studying excitons, a number of phenomena that shaped important avenues of progress in exciton physics. His discovery of two exciton series in Cu_2O spectra proved that it was possible to analyze complex band structures of semiconductors using narrow-band exciton spectra. The Zeemann and Stark effects in exciton spectra were observed for the first time in Cu_2O placed in external electric and magnetic fields. Specific effects caused by large radii of excitons were exposed — exciton ionization in a weak external electric field (1954), and giant diamagnetic shift of exciton levels in a magnetic field (1955). Absorption oscillation due to the creation of Landau levels were detected in magnetic fields outside the exciton series (1957). These observations in the Cu_2O spectra, as well as independent observations of magnetic absorption oscillations in Ge (B Lax and S Zwerdling) and in InSb (E Burstein and G S Picus), were precursors of modern semiconductor magnetooptics. In the 1960s, subsequent work by Zakharchenya in collaboration with R P Seisyan proved the existence of quasi-one-dimensional diamagnetic excitons. In 1961, Zakharchenya and D Thomas and J Hopfield independently observed in the spectra of cadmium sulfide crystals the effect of inversion of a magnetic field, directly related to the momentum carried by excitons. In 1966, Zakharchenya and a group of colleagues were awarded the Lenin Prize for that year for studies on excitons in semiconductors. In the same year he successfully maintained his doctoral dissertation "Magnetooptic phenomena in crystals".



Boris Petrovich Zakharchenya
(01.05.1928 – 10.04.2005)

The next stage in the creative biography of Zakharchenya began in the 1970s. Started from the idea of the symmetry analogy between a magnetic field and circularly polarized light and from the results obtained in atomic spectroscopy, Zakharchenya initiated and headed experimental investigation into the optical orientation of electron and nuclear spins in semiconductors under irradiation with circularly polarized light. The results of these studies clarified many important dynamic electron and electron-nuclear processes in semiconductors. Zakharchenya and V G Fleisher reported in their publications deep optical cooling (down to 10^{-6} K) of the

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nuclear spin system, the optical orientation of holes, and many other phenomena. A series of studies on optical orientation in semiconductors, carried out by Zakharchenya and his colleagues at FTI, was awarded in 1976 a USSR State Prize. In the same year Zakharchenya, together with D N Mirlin and other collaborators, discovered a new physical phenomenon in semiconductors: momentum alignment of high-energy ('hot') photoelectrons under irradiation with polarized light. Experimental and theoretical work (V I Perel', M I D'yakonov) showed that the steady-state studies of hot photoluminescence, including those in magnetic fields, holds great promise for exploring the energy and momentum relaxation of carriers and for determining ultrashort (down to femtosecond) relaxation times in semiconductors.

The collective monograph *Optical Orientation*, published in 1984 by North-Holland (edited by B P Zakharchenya and F Meier) and reprinted in Russian in 1989, summarized the achievements of world science in this very important novel field of solid-state physics.

The spectroscopical and magnetooptical methods developed earlier for bulk semiconductors were successfully used by Zakharchenya and his team in subsequent years to study spin-based phenomena in quantum-dimensional semiconductor structures. Optical orientation was observed in quantum wells (the discovery of giant anisotropy of the hole g-factor) and in quantum dots (the observation of quantum beats of electron spin). The focus in bulk material studies was placed on working with magnetically mixed semiconductors (the optics of magnetic polarons). The work by Zakharchenya and his colleagues (Yu G Kusraev, R I Dzhioev, V L Korenev) played an important role in the coming of age of modern ideas related to using spin-based phenomena in electronics ('spin electronics' or 'spintronics').

In 1996, Zakharchenya won the P N Lebedev Large Gold Medal of the RAS for his work on optical spin orientation and alignment of electron momenta in semiconductors and semiconductor quantum-dimensional structures. He received the W Hanle Prize (Germany) in 1998 for his contribution to optical orientation in semiconductors and the A G Aronov International Foundation Prize in the same year for his work on hybrid semiconductor – ferromagnet structures. He also received the prize of the R Abramovich and O Deripaska Regional Foundation for the Advancement of Russian Sciences.

For many years after 1989 Boris Petrovich was Director of the FTI Solid State Physics Division comprised of 15 laboratories. These were the years of political and economic reforms in Russia, accompanied with a sharp decline in research funding. In these difficult times Zakharchenya proved to be an active and able administrator who did a lot to preserve the research potential and material assets of the team entrusted to him, and to strengthen its international ties. He was able to assemble rich material on the many years of collaboration between FizTekh scientists and German physicists, ever since the time when Ioffe, the founder of the Institute, worked in Roentgen's laboratory. The collection created quite a stir in the scientific community and helped FizTekh in obtaining substantial financial support for renovations from a German foundation (The Messerschmidt Foundation) that sponsors foreign institutions that in the past had haven close ties to Germany. In 2001 – 2002, Zakharchenya held the guest professorship at Wurzburg University (as the Mercator Professor).

Zakharchenya supervised the research work and the viva voce procedure for more than 20 Candidate theses; eight holders of the DSc degree regard him as their scientific supervisor. From 1973 he held the professorship at the Optoelectronics Chair of the St.-Petersburg Electrotechnical University where he lectured for senior-year students and conducted colloquia. Beginning in 1988 Zakharchenya was the Editor-in-Chief of the journal *Fizika Tverdogo Tela* (*Solid State Physics*). He was a Fellow of the American Physical Society, and for a number of years sat on the Commission on Semiconductors of IUPAP.

Zakharchenya's talents were not confined to physics. He had undisputed capabilities in the humanities and a considerable literary talent (he learned to read at the age of two and, as he would confess early in life, hesitated whether to enrol in the physics or philology department of the university). He had a profound knowledge of Russian poetry and would perform masterly recitals of poems of Pushkin, Blok, Zabolotsky, Mandel'shtam, and David Samoilov (Samoilov was Zakharchenya's close friend). He was an expert in the history of fine arts, and in particular of the Russian avant-garde, and was proud of the fact that he was instrumental in the 'discovery' of the well-known artists Minas Avetisyan and Avtandil Varazi. Boris Petrovich published essays and reminiscences of his meetings with brilliant personalities of the world of arts and sciences in such literary periodicals as *Nashe Nasledie* (*Our Heritage*), *Avrora*, and *Neva*. Zakharchenya left a number of unpublished literary pieces that will hopefully find a publisher.

Zakharchenya possessed a rare gift for communication; he was always interesting company to even the most different of people. His memory was astounding and as a storyteller he was without equal. His imaginative, emotionally charged addresses to various meetings of colleagues, often unconventional in form and content, never left his audience indifferent. The way Zakharchenya looked was also quite distinctive: a very tall, slightly stooped figure, always elegantly dressed, easily recognizable from afar in the corridors of FizTekh.

For more than a year Zakharchenya had fought valiantly against the fatal illness that befell him. All this time his wife Ruslana, his colleagues, and his friends were with him and he continued to play his part in the life of his Institute. His memory — as brilliant scientist and human being — will live on in our hearts. One of the minor planets of the Solar system already bears the name of Boris Petrovich Zakharchenya.

E B Aleksandrov, Zh I Alferov, A F Andreev,
D A Varshalovich, A G Zabrodskii, Yu M Kagan,
A A Kaplyanskii, L V Keldysh, O N Krokhin,
B V Novikov, V I Perel', R A Suris