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PERSONALIA

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Aleksei Alekseevich Abrikosov (on his 80th birthday)

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Aleksei Alekseevich Abrikosov

Professor Aleksei Alekseevich Abrikosov, a brilliant theoretical physicist, Nobel Prize winner, and Full Member of the Russian Academy of Sciences turns 80 on June 25, 2008.

A A Abrikosov spread his wings as a scientist under the direct influence of L D Landau. While still only 19, he successfully passed Landau's 'Theoretical Minimum' exams, a year later graduated *summa cum laude* from the Physics Department of Moscow State University, a year later submitted and defended his CandSc thesis, and in 1955, at just 27 years of age, defended his DSc thesis.

The 1950s were the years of rapid progress in quantum electrodynamics and solid-state physics. Together with L D Landau ad I M Khalatnikov, A A Abrikosov published in 1954 a fundamental paper that later gained the code name 'Moscow zero': it calculated Green's functions and effective cross sections for the Compton effect and of mutual scattering of electrons and positrons at high energies. The new computing methods devised in that work, based on summing up the main sequences of the diagrams, were later used for solving a number of problems in statistical physics. These methods, together with some other beautiful ideas such as the temperature diagram technique for obtaining kinetic characteristics at finite temperatures, formed the basis of the monograph *Methods of Quantum Field Theory in Statistical Physics*, written by him together with L P Gor'kov and I E Dzyaloshinskii. This book was the first in this new field of theoretical physics and became a desktop must for theoreticians the world over.

In 1957, A A Abrikosov published what was probably his best-known paper, without which it is impossible now to imagine what the physics and technology of superconductivity would be like. It formulated the concept of type II superconductivity, developed the theory of the magnetic properties of such superconductors, which explained the accumulated experimental material, and discovered the occurrence of two critical fields and a mixed state phase between the two, when a magnetic field partly penetrates into the superconductor in the form of quantum current vortices — Abrikosov's vortex filaments. His prediction of a regular lattice of such vortices was a brilliant theoretical feat; it was soon observed and is known as the Abrikosov lattice. This paper is one of the most often cited in world scientific literature.

Following the discovery of type II superconductivity, A A Abrikosov obtained a number of most important results in the just-developed microscopic theory of superconductivity. Among these were an analysis of high-frequency properties of superconductors, the development of microscopic methods for studying scattering of electrons by impurities, the study of the properties of superconductors doped with magnetic impurities, the discovery of zero-gap superconductivity, the explanation of the Knight shift, and the calculation of the intensity of Raman light scattering in normal metals and superconductors. In time, the superconductivity achievements of the outstanding Russian physicists Ginzburg, Landau, Abrikosov, and Gor'kov came to be abbreviated in Western literature as the acronym GLAG.

In the 1960s, A A Abrikosov's academic interests shifted to the area of the theory of normal metals, semimetals, and semiconductors. He worked on the Kondo problem, studying the conductivity of metals with magnetic impurities, and discovering that, depending on the sign of exchange interaction, the effective scattering either vanishes or greatly increases (this phenomenon became known as the Abrikosov – Suhl resonance). A A Abrikosov and his team developed the theory of semimetals of the bismuth type and zero-gap semiconductors. The crystal structure of semimetals was explained and symmetry types allowing a gapless spectrum and being stable against the electron – electron interaction were revealed, the spectrum of charge carriers and its behavior under pressure were analyzed, and exciton phases in a magnetic field were investigated. This work is especially in demand today in connection with the discovery of graphene

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and the prospects that this discovery promises in nanoelectronics.

In 1970s – 1980s, A A Abrikosov took part in the creation of the theory of quasi-one-dimensional systems and studied the properties of spin glasses. He devised an ingenious technique for calculating the conductivity of quasi-one-dimensional metals that made it possible to take into account the hopping of electrons between filaments and their scattering on phonons and impurities. A A Abrikosov conducted a vigorous program of research, teaching, and science management at the L D Landau Institute of Theoretical Physics in Chernogolovka, of which he was one of the founding fathers, at the Institute for High Pressure, RAS in Troitsk where he was elected Director in 1988, and at the Chair of Theoretical Physics occupied by him at the Moscow Institute of Steel and Alloys (*Russ. abbr.* MISiS). In 1988, A A Abrikosov published a textbook *The Fundamentals of the Theory of Metals*, based on the courses of brilliant lectures that he was delivering at MGU, MFTI, and MISiS. This book is an encyclopedia of the theory of normal metals and superconductors and is the principal textbook of the physics of the condensed state for students and research workers.

At the beginning of the 1990s, A A Abrikosov accepted the proposal to head the Theoretical Department of the Argonne National Laboratory and moved to the USA. The most pressing problem in the theory of the condensed state at the time was that of explaining the phenomenon of high-temperature superconductivity, so A A Abrikosov started working in this field in close cooperation with experimenters at Argonne Lab. They discovered a very specific peculiarity in the spectrum of cuprate superconductors, after which A A Abrikosov suggested his own version of the theory of high-temperature superconductivity, which explained and put into a common framework a multitude of available experimental facts.

A A Abrikosov's scientific work and results are widely known and have long been enjoyed international recognition. He received the Lenin and State Prizes and the International Fritz London Award, holds degrees *honoris causa* from many European and American universities, and is a Full Member of the Russian Academy of Sciences, a Member of the National Academy of Sciences of the United States of America, and a Member of the American Academy of Arts and Sciences, a Foreign Member of the Royal Society of London, and a Member of the Hungarian Academy of Sciences. In 2003, he became a laureate of the Nobel Prize in Physics jointly with V L Ginzburg and A J Leggett "for pioneering contributions to the theory of superconductors and superfluids".

Anyone who has had the pleasure of meeting A A Abrikosov, working with him, or taking part in the symposia on theoretical physics that he regularly organizes enjoys his erudition, his excellent gift of storytelling, his exceptional writing talents, his enviable principles, his kindness, and his readiness to give help and real support in times of hardship.

We use this occasion to wish Aleksei Alekseevich happy birthday, as well as good health and new achievements in science.

A F Andreev, A I Buzdin, A A Varlamov,
Yu Kh Vekilov, L P Gor'kov, I E Dzyaloshinskii,
Yu M Kagan, S I Mukhin, Yu A Osip'yan,
L P Pitaevskii, S M Stishov, L A Falkovsky