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PERSONALIA

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In memory of Yurii Aleksandrovich Izyumov

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Yurii Aleksandrovich Izyumov, world-famous scientist, head of the Ural scientific school of theoretical physicists, Full Member of the Russian Academy of Sciences, laureate of the USSR State Prize, doctor of physicomathematical sciences, professor, scientific leader of the Department of Theoretical and Mathematical Physics of the Institute of Metal Physics, Ural Branch of the Russian Academy of Sciences, passed away on 20 July 2010, at the age of 77.

Yu A Izyumov's entire life was connected with the Ural region. He was born on 28 May 1933, in Sverdlovsk (now Ekaterinburg). He graduated from Ural State University and was offered a postgraduate course at the Chair of Theoretical Physics under the guidance of Academician S V Vonsovskii. From 1959 to the end of his life, Yurii Aleksandrovich worked at the Institute of Metal Physics. He founded and for many years headed the Laboratory of Solid-State Theory, which was later converted into the Department of Mathematical and Theoretical Physics; he was the Chairperson of the Scientific Council of the Institute of Metal Physics on the problem of the Electronic Properties of Condensed Media. In 1960, he defended his candidate's dissertation, and in 1967 he defended his doctoral dissertation. In 1991, he was elected a Corresponding Member of the Russian Academy of Sciences, and in 2006 became a Full Member of the Russian Academy of Sciences.

Yu A Izyumov was a specialist in the field of solid-state theory; he was the author of more than 200 published scientific works, including 15 monographs. The basic areas of his scientific activity were the theory of magnetic and crystal structures and phase transitions, neutron diffraction, quantum theory of magnetically ordered crystals, superconductivity, and the theory of strongly correlated electron systems.

Yu A Izyumov and his colleagues developed the theoretical bases of neutron diffraction and neutron spectroscopy of magnets, created the theory of neutron scattering in magnetically ordered crystals with a wide application of magnetic-symmetry concepts (apparatus of the theory of space-group representations), and suggested efficient methods of interpretation of magnetic structures and spectra of magnetic excitations. These methods are widely applied in a number of neutron diffraction centers in our country and abroad. Detailed studies into polarization effects of neutron scattering in magnets were carried out and efficient methods of resolution of the cross sections of inelastic magnetic and nuclear scattering were proposed. Two polarization effects in neutron scattering on spiral magnetic structures were predicted and later discovered experimentally. A complete theory of neutron diffraction on incommensurate magnetic structures was developed, including diffraction on a soliton lattice. This work had a substantial effect on the advancement of domestic and world science which uses neutrons as a tool for studying solids. In 1966, Yu A Izyumov and R P Ozerov wrote the first monograph in the world on magnetic structure analysis by neutron diffraction, which even now remains a handbook of many experimentalists who deal with neutron diffraction. Subsequently, Yu A Izyumov and co-authors wrote three more monographs on the problems of neutron scattering in solids. He repeatedly gave lectures on these problems in the largest neutron diffraction centers in the world, such as Brookhaven, Argonne, Oak Ridge (USA), Risø (Denmark), and Trombay (India). In 1986, Yu A Izyumov, as a member of a collective of authors, was awarded the USSR State Prize for work on the creation of new methods of studying solids using neutron scattering methods.

Yu A Izyumov and his colleagues carried out a wide cycle of studies on magnetic and structural phase transitions in crystals on the basis of a phenomenological approach and developed an efficient method of constructing the order

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parameter on the basis of the symmetry theory. Yu A Izyumov advanced the idea of exchange multiplets and developed it with regard to phase transitions in magnets. As long ago as the 1960s, Yu A Izyumov and his colleagues constructed a detailed theory of magnetically ordered crystals with impurities. The quasilocal peak in the magnon spectrum predicted in this theory was revealed experimentally in the case of a weakly bound impurity. The exact solution to the problem of two antiferromagnetically coupled atoms placed in a ferromagnetic matrix became the basis for the understanding of the anomalous properties of alloys with mixed exchange interactions, intensive experimental studies of which for many years were conducted in the Institute of Metal Physics, UrB RAS.

An important contribution was introduced by Yu A Izyumov and his colleagues to the development of the mathematical apparatus of the theory of magnetically ordered systems. In particular, they constructed a convenient version of the diagrammatic technique for spin operators and developed the representation of the partition function of the quantum Heisenberg model in the form of a continual integral. The investigation of the interaction of electronic and magnetic degrees of freedom in d and f metals was initiated in the postgraduate work of Yu A Izyumov under the guidance of Academician S V Vonsovskii. Within the framework of the s–d model, he calculated the spin–wave spectrum of a ferromagnetic metal and the decay of spin waves due to their scattering on conduction electrons. In the ferromagnetic semiconductor, a bound state of the electron and a spin wave was discovered, which forms a magnetic polaron.

For the Hubbard model and its limiting case — the $t-J$ model — Yu A Izyumov and his colleagues developed a diagrammatic technique for X operators which describe the motion of strongly correlated electrons, and proposed a generalized approximation of chaotic phases, which was applied to obtain a fundamentally new expression for the magnetic susceptibility reflecting the dualism in the behavior of the magnetic states in strongly correlated systems. It has been shown that this susceptibility simultaneously manifests the features of both collectivized and localized models.

Under the guidance of Yu A Izyumov, a method of the generating functional was developed for describing strongly correlated systems, which is an extension of the Kadanoff–Baym method (which was used earlier for usual Fermi systems) to the case of systems in which the operators of creation and annihilation do not commute with C-numbers (the spin and X operators). The generating functional takes into account the interaction of a system with the fluctuating external fields, and the various Green's functions of the system are expressed through the variational derivatives with respect to these fields. This approach was applied to all fundamental models of magnetism, i.e., Heisenberg, Hubbard, $t-J$, and s–d models. It turned out that the structure of Green's functions for different models has much in common. Thus, the structure of the dynamic susceptibilities in the dielectric and conducting models was shown to be isomorphic, which is caused by the similarity of the commutation relations for the spin and X operators. The method of the generating functional made it possible from a united viewpoint to embrace the different models in the theory of strongly correlated and spin systems.

The first work of Yu A Izyumov and his co-authors on superconductivity concerned the problem of the coexistence of superconductivity and ferromagnetism in the same volume of a material. Later on, essential results were obtained concerning the phases coexisting in heterogeneous F/S structures consisting of layers of ferromagnetic and superconducting metals. In the last years, under the guidance of Yu A Izyumov promising investigations of the electronic structure of compounds with strong correlations were carried out by the methods of the dynamic mean field theory, and of the physical properties and electronic models of a new class of high-temperature superconductors in layered iron-based compounds.

A characteristic feature of the scientific work of Yu A Izyumov was a skillful combination of concrete original studies and a wide generalization of the results of studies in monographs or surveys. His books were a great success; many of them have been translated into English.

Yu A Izyumov conducted much pedagogical and science-organization work. For 25 years, he was a professor of Ural State University. Among Yurii Aleksandrovich's main hobbies were literature, art, and music. His numerous essays in popular editions were excellent samples of the popularizing work of a great scientist.

Yurii Aleksandrovich was an example of selfless devotion to science, purposefulness, and enormous working efficiency, a combination of an enormous force of will with a warmth for and benevolence to surrounding people.

The cherished and kind memory of Yurii Aleksandrovich Izyumov, an outstanding theoretical physicist and remarkable person, will be forever preserved in the memory of all the people who knew him.

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